Vol. 11, No. 14
July 31, 1986

Energy Research Abstracts

Abstracts 31295-33492

Office of Scientific & Technical Information
UNITED STATES DEPARTMENT OF ENERGY

CURRENT AWARENESS PUBLICATIONS ON ENERGY

To provide complete coverage of literature related to major Department programs, announcement publications that are comprehensive in their coverage of certain energy fields are issued regularly. All information in these publications, plus additional backup information, is included in the Energy Data Base of the Office of Scientific and Technical Information; all references are also available for machine searching via the on-line retrieval system, DOE/RECON, and the commercial on-line retrieval systems. Descriptions of these current awareness publications, which are supported either directly or indirectly by the DOE, appear below. Department of Energy components may receive the listed publications free from the Office of Scientific and Technical Information, U. S. Department of Energy, P. O. Box 62, Oak Ridge, TN 37831. Telephone (615) 576-1301; FTS 626-1301.

PUBLICATIONS OF THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

Energy Abstracts for Policy Analysis (EAPA)

A monthly abstract journal devoted to the analysis of energy research, conservation, and policy. Scope and coverage are limited to substantive articles or reports and emphasize legislative, regulatory, and other legal aspects, as well as social, economic, and environmental impacts. *EAPA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price is $72.00 for domestic (North America) or $90.00 for foreign (outside North America) subscribers; a single issue is $5.00 or $6.25, respectively.

Energy Research Abstracts (ERA)

A comprehensive semimonthly abstract journal devoted to all areas of energy-related information produced by the Department of Energy, other U. S. government organizations, and foreign governments. *ERA* is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The annual subscription price for the 24 issues is $146.00 for domestic (North America) subscribers or $182.50 for foreign (outside North America) subscribers. A single issue is $14.00 or $17.50, respectively.

DOE Patents Available for Licensing (PAL)

DOE is prepared to grant exclusive or nonexclusive, revocable licenses under DOE-owned U. S. patents and patent applications; this semiannual publication provides abstracting and indexing coverage of this literature. *PAL* is available (use PB86-946800) from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The annual price is $18.00 for domestic (North America) or $36.00 for foreign (outside North America); a single issue is $9.00 or $18.00, respectively.

Energy Meetings (EM)

A monthly listing of conferences, symposia, workshops, etc., pertaining to DOE's programmatic interests. *EM* is available on subscription (use PB86-901500) from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. The annual subscription price is $45.00 for domestic subscribers and $90.00 for subscribers outside the North American continent; a single issue is $5.00 and $10.00, respectively.

The following monthly update journals are available to the public on subscription from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; use the identifying order number (PB- No.) when subscribing. The annual subscription price (12 issues plus cumulative index) is $85.00 for domestic (North America) and $170.00 for foreign (outside North America) subscribers; a single issue is $8.00 and $16.00, respectively.

Current Energy Patents (CEP)–**PB86-902800.** International patent literature, including patent applications, on any aspect of energy production, conservation, and utilization.

Energy and the Environment (EAE)–**PB86-914900.** Impacts of energy-related activities and radioactive and nonradioactive pollutants on the environment.

Fossil Energy Update (FEU)–**PB86-914600.** The exploration, development, processing, and use of fossil fuels.

Fusion Energy Update (CFU)–**PB86-915300.** Information on controlled thermonuclear fusion, including plasma and fuel research and power plant engineering and conceptual design studies.

Solar Energy Update (SEU)–**PB86-914500.** The utilization of solar energy, including biomass and tidal and wind power.

The following semimonthly bulletins are also available from the National Technical Information Service. The annual subscription rate for one volume (calendar) year (24 issues; no indexes) is $45.00 for domestic (North America) and $90.00 for foreign (outside North America) subscribers; use the identifying order number (PB- No.) when subscribing.

Acid Precipitation (APC)–**PB86-901000.** Acid precipitation, including effects and possible control measures.

Buildings Energy Conservation (BEC)–**PB86-900700.** Technology required for energy conservation in buildings of all types.

Coal-Based Synfuels (CBS)–**PB86-901400.** Conversion of coal into gaseous or liquid fuels.

Coal Combustion and Utilization (CCU)–**PB86-914400.** Coal combustion, including fluidized bed combustion, and direct utilization of coal for power generation, fuel cells, and MHD generators.

Coal Preparation and Pollution Control (CPC)–**PB86-900800.** Coal preparation and cleaning and reducing pollution from its direct combustion.

Direct Energy Conversion (DEC)–**PB86-946600.** Photovoltaics, magnetohydrodynamics, electrohydrodynamics, thermoelectrics, thermionics, and fuel cells.

Energy from Biomass (EFB)–**PB86-900600.** Biomass production, conversion, and utilization for energy.

Geothermal Energy Technology (GET)–**PB86-914700.** Exploration, development, and utilization of geothermal resources.

Heavy-Ion Reactions (HIR)–**PB86-900500.** Heavy-ion (A > 4) reactions.

Laser Research (LAR)–**PB86-901100.** Laser research and development, excluding applications.

Nuclear Fuel Cycle (NFC)–**PB86-913400.** Both front and back ends of the nuclear fuel cycle.

Nuclear Reactor Safety (NRS)–**PB86-913500.** Accident analysis, safety systems, radiation protection, decommissioning and dismantling, and security measures.

Radioactive Waste Management (RWM)–**PB86-902900.** Management aspects of transport and storage, waste processing, waste disposal, waste storage, radioactive effluents, and shipping containers.

Solar Thermal Energy Technology (STT)–**PB86-901200.** Research and development of efficient and reliable solar thermal conversion systems.

Transportation Energy Research (TER)–**PB86-900900.** Energy-efficient advanced automotive propulsion systems and transportation energy conservation.

Unconventional Petroleum (UCP)–**PB86-901300.** Secondary and tertiary recovery of petroleum and oil shales and tar sands.

INTERNATIONAL ENERGY PUBLICATIONS

The Office of Scientific and Technical Information (OSTI) cooperates in the publication of international abstract journals with the following: (1) International Atomic Energy Agency, International Nuclear Information System, Vienna, Austria, for *Atomindex;* (2) International Energy Agency, Biomass Conversion Technical Information Service, Dublin, Ireland, for *Biomass Abstracts;* and (3) International Energy Agency, IEA Coal Research, London, England, for *Coal Abstracts.* In each case, the cognizant foreign agency provides the non-U. S. information to OSTI for inclusion in the Energy Data Base; in turn, OSTI provides the U. S. information for input into the respective journal.

Atomindex

A semimonthly abstract journal providing worldwide coverage of information on nuclear science and technology. *Atomindex* is available by subscription from UNIPUB, 345 Park Avenue South, New York, NY 10010. The cost of an annual subscription, 24 semimonthly issues and semiannual and annual cumulative indexes, is $290.

Biomass Abstracts

A bimonthly abstract journal with comprehensive coverage of information on the conversion of biomass to energy. *Biomass Abstracts* is available free to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Biomass Abstracts* from Biomass Conversion Technical Information Service, Institute for Industrial Research and Standards, Ballymun Road, Dublin 9, Ireland, for 42 IR pounds per year. Make checks payable to the Institute.

Coal Abstracts

A monthly abstract journal providing comprehensive worldwide coverage of information in the field of coal science and technology. *Coal Abstracts* is available to DOE components and contractors from OSTI. Non-DOE organizations may obtain *Coal Abstracts* from IEA Coal Research, Technical Information Service, 14-15 Lower Grosvenor Place, London SW1W 0EX, England, for 100 pounds sterling per year.

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ENERGY RESEARCH ABSTRACTS

ABOUT THE OFFICE OF SCIENTIFIC AND TECHNICAL INFORMATION

The Office of Scientific and Technical Information (OSTI) in Oak Ridge, Tennessee, has been the national center for scientific and technical information for the Department of Energy (DOE) and its predecessor agencies since 1946. In developing and managing DOE's technical information program, OSTI places under bibliographic control not only DOE-originated information but also worldwide literature on scientific and technical advances in the energy field and announces the source and availability of this information. Whereas the literature of science is emphasized, coverage is extended to DOE programmatic, socioeconomic, environmental, legislative/regulatory, energy analysis, and policy-related areas. To accomplish this mission, OSTI builds and maintains computerized energy-information data bases and disseminates this information via computerized retrieval systems and announcement publications such as abstracting journals, bibliographies, and update journals. Direct access to OSTI's most comprehensive data base, the Energy Data Base, is available to the public through commercial on-line bibliographic retrieval systems. The Energy Data Base and many of OSTI's energy-related data bases are available to DOE offices and contractors and to other government agencies via DOE/RECON, the Department's on-line information retrieval system. The Office of Scientific and Technical Information has developed and maintains systems to record and communicate energy-related research-in-progress information, to maintain a register of DOE public communications publications, to track research report deliverables from DOE contractors, and to test and make available DOE-funded computer software programs with scientific and management applications; OSTI also serves as adviser for special publication needs of the Department. To effectively manage DOE's technical information resources, OSTI's program is one of continual development and evaluation of new information products, systems, and technologies.

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ABOUT *ENERGY RESEARCH ABSTRACTS*

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U. S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. The user should remain aware that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.

ERA is comprehensive in its subject scope, encompassing the DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

ERA is available on an exchange basis to universities, research institutions, industrial firms, and publishers of scientific information. Inquiries should be directed to the Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831.

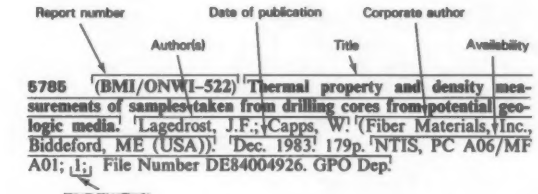
ERA is available to the public on a subscription basis from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The subscription rate for the 24 semimonthly issues is $146.00 for domestic subscribers and $182.50 for foreign subscribers. A single issue costs $14.00 (domestic) or $17.50 (foreign). The cumulative indexes will be available in printed form from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. The GPO Stock Number is 061-000-00675-3 and the price is $124.00 for the Vol. 10 indexes. The cumulative indexes are also available in microfiche form from the National Technical Information Service, U. S. Department of Commerce, Springfield, VA 22161, and from Engineered Systems, P. O. Box 866, Oak Ridge, TN 37831.

Office of Scientific and Technical Information
United States Department of Energy, P. O. Box 62, Oak Ridge, TN 37831

HOW TO USE *ENERGY RESEARCH ABSTRACTS*

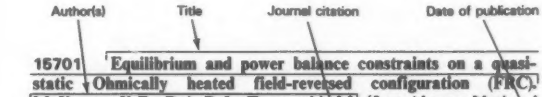
ABSTRACTS IN *ENERGY RESEARCH ABSTRACTS*

The principal elements of abstract entries for a typical research and development report and a typical technical journal article are illustrated below.



5785 (BMI/ONWI-522) **Thermal property and density measurements of samples taken from drilling cores from potential geologic media.** Lagedrost, J.F.; Capps, W. (Fiber Materials, Inc., Biddeford, ME (USA)). Dec. 1983. 179p. NTIS, PC A06/MF A01; 1; File Number DE84004926. GPO Dep.

Abstract: Density, steady-state conductivity, enthalpy, specific heat, heat capacity, thermal diffusivity and linear thermal expansion were measured on 59 materials from core drill samples of several geologic media, including rock salt, basalt, and other associated rocks from 7 potential sites for nuclear waste isolation. The measurements were conducted from or near to room temperature up to 500°C, or to lower temperatures if limited by specimen cracking or fracturing. Ample documentation establishes the reliability of the property measurement methods and the accuracy of the results.



15701 **Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC).** McKenna, K.F.; Rej, D.J.; Tuszewski, M. (Los Alamos National Lab., NM (USA)). *Nuclear Fusion;* **23**: No. 10, 1319-1325 (Oct 1983).

Abstract: Zero-dimensional power balance calculations are performed for a quasi-static, purely Ohmically heated field-reversed configuration. Without compression, the constraint imposed by radial pressure balance limits the power input. Estimates of the energy loss from impurity line radiation as well as from classical and anomalous transport are given. Effects of cold puff gas injection are also investigated.

INDEXES TO *ENERGY RESEARCH ABSTRACTS*

Five indexes are provided for approaching the contents of each issue of *Energy Research Abstracts (ERA).* Each index is preceded by an introduction that details the organization of the index and the principles by which it was compiled. The reader is referred to these introductions for information not found in the index examples that follow.

● Corporate Author Index

Technical report literature is indexed using the name of the organization or institution responsible for the issuance of the report.

5785 (BMI/ONWI-522) **Thermal property and density measurements of samples taken from drilling cores from potential geologic media.** Lagedrost, J.F.; Capps, W. **(Fiber Materials, Inc., Biddeford, ME (USA)).** Dec. 1983. 179p. NTIS File Number DE84004926. GPO Dep.

is indexed as:

Fiber Materials, Inc., Biddeford, ME (USA)

● Personal Author Index

Each author's name is indexed in the form appearing on the document abstracted, with the exception that given names are reduced to initials:

Capps, W., *See* Lagedrost, J. F.
Lagedrost, J.F., Thermal property and density measurements of samples taken from drilling cores from potential geologic media, 9:5785 (R;US)
McKenna, K.F., Equilibrium and power balance constraints on a quasi-static Ohmically heated field-reversed configuration (FRC), 9:15701 (J;US)
Rej, D.J., *See* McKenna, K.F.
Tuszewski, M., *See* McKenna, K.F.

● Subject Index

The subject index consisting of entries naming specific materials, objects, and processes is arranged alphabetically. Document titles, informative phrases, or both specific to these entries are arranged alphabetically under the entries.

SALT DEPOSITS
Density
Thermal property and density measurements of samples taken from drilling cores from potential geologic media, 9:5785 (R;US)
REVERSED-FIELD PINCH
Energy Balance
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● Contract Number Index

DOE technical report literature is indexed using contract numbers. This index contains the contract number with corresponding abstract and report numbers.

AC06-76RL01830	**Fiber Materials, Inc., Biddeford, ME (USA)**	
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● Report Number Index

Technical report literature is also indexed using report numbers. This index includes information on where individual reports may be obtained. Patents and conference papers are indexed here as a matter of convenience. When a report is supplied under a File Number, that number is included in the availability statement. A file number–report number correlation is included for convenience.

BMI/ONWI-522	9:5785	NTIS, PC A09/MF A01. File Number DE84004926, Distribution Category MN-70

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Foreign Sources

CEA Centre d'Etudes de Saclay
GIF-sur Yvette Cedex, France

Fachinformationszentrum
Energie, Physik, Mathematik GmbH
Karlsruhe, Federal Republic of Germany

IEA Biomass Conversion Service
Dublin, Ireland

IEA Coal Research
Technical Information Service
London, England

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Oak Ridge, TN

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Springfield, VA

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Bethesda, MD

NOVA Information Services Company
Commack, NY

Plenum Publishing Corporation
New York, NY

University of Tennessee
Graduate School of Library and Information Sciences
Knoxville, TN

Communication concerning the editorial policy and content of *Energy Research Abstracts* should be addressed to the Editor, *Energy Research Abstracts,* Office of Scientific and Technical Information, P. O. Box 62, Oak Ridge, TN 37831.

SUBJECT CONTENTS (NUMERICAL LISTING)

Six-digit subject category numbers are used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's computerized bibliographic information system. The six-digit category numbers are utilized as if they were three pairs of two-digit numbers, the first two pairs being used to arrange the abstract content of *Energy Research Abstracts*. The following listing includes the totality of the 39 first-level and 293 second-level subject categories used. Because each issue of *ERA* announces only those documents becoming available during a semi-monthly period, some subject categories may not be represented in every issue. The complete subject category scheme with scope definitions and limitations is available as DOE/TIC-4584-R6 from NTIS for $9.50.

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REFER ALSO TO CITATION(S) 31335, 31335, 31357, 31358, 31363, 31365, 31374, 31775, 31783, 32112, 32236, 32359

31295 (ANL/FE—85-13) Comparison of results of 200- and 500-h exposures of silicon carbide to a slagging coal gasification environment. Easler, T.E. (Argonne National Lab., IL (USA)). Apr 1986. Contract W-31-109-ENG-38. 21p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010625.

The corrosion behavior of silicon carbide was studied in laboratory tests to determine whether the material has potential for use in the hot, dirty gas stream issuing from a slagging coal gasification vessel. In this report, the results of 500-h exposure tests of a siliconized silicon carbide material are compared to earlier reported results of 200-h tests in the same environment. It was found that specimens exposed to typical effluent gas compositions in the absence of slag formed surface oxide scales, the growth rate of which increased slightly with time, possibly as a result of accelerated oxidation in the presence of the high steam partial pressure. Acidic-slag-coated samples exhibited an increase in corrosion rate with exposure time, while the corrosion rate for basic-slag-coated samples remained nearly constant. Corrosion products included an iron-rich phase, possibly Fe_3Si, which penetrates specimens along grain boundaries, where it interacts with the free silicon in the material. A silica-rich layer, which does not seem to greatly inhibit reactant and product diffusion, was also observed at the slag/silicon carbide interface. Strength degradation was most notable for the basic-slag-coated samples; the measured strengths were less after the longer-term 500-h exposure period than were observed after the 200-h tests. The test results indicate a rather limited life expectancy for silicon carbide in the hot, dirty gas stream. 12 refs., 6 figs., 4 tabs.

31296 (BMFT-FB-T—85-153) Steam gasification of coal. Project prototype plant nuclear process heat. Final report. Heek, K.H. van; Beyer, H.D.; Hardt, L.; Jockers, R.; Kirchhoff, R.; Kubiak, H.; Schroeter, H.J.; Sulimma, A.; Wiegand, D. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 200p. (In German). NTIS (US Sales Only), PC A09/MF A01. File Number DE86751998.

This report describes the work performed at Bergbau-Forschung GmbH to develop the allothermal gasification of hard coal by steam within the framework of the PNP-project and reviews the relevant results. In the semitechnical pilot plant, the operation of which has been ended by the 30th of June 1984, all tasks relevant and important for the project have been performed successfully. Especially the continuous gasification of caking high volatile bituminous coal has been demonstrated. Thus there exists a large number of experimental data and operating experiences which can be used for the design of bigger plant, especially of the prototype plant. Moreover the scientific and technical know-how, which has been achieved by the operation of different devices - laboratory work, semitechnical pilot plant, engineering models - can be utilized for conventional coal processing. (orig.). Following report of BMFT-FB-T--82-069. With 38 refs., 39 tabs., 117 figs.

31297 (CONF-8604144—5) Optimization of coal devolatilization model parameters for comprehensive gasification and combustion models. Baxter, L.L.; Smith, P.J.; Smoot, L.D. (Brigham Young Univ., Provo, UT (USA). Combustion Lab.). 1986. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010288.

From Spring meeting of the Western States Section of the Combustion Institute; Alberta, Canada (28 Apr 1986).

Parameters for empirical devolatilization models are recommended for lignite and bituminous coals. These parameters were generated by combining optimization algorithms with rigorous particle and flow field modeling of experimental facilities. PCGC-2, a comprehensive, axisymmetric, gasification and combustion code developed at the Brigham Young University Combustion Laboratory, was used to predict the velocity, temperature, and radiation fields of experimental apparatus used to collect devolatilization data. The effect of changing devolatilization models on these fields were neglected due to very low particle loadings. These fields were subsequently entered into a rigorous particle reaction model and the particle response to them was predicted. A particle model predicted the trajectories, temperature, and reaction rates of coal particles in the flow fields described above. The particle model and its results are discussed. The particle model was coupled with an optimization algorithm to determine optimum parameters for the two-reaction devolatilization model. Generalized reduced gradient (GRG) and sequential quadratic programming (SQP) methods were used in performing the optimization with OPIDES, an optimization program developed at Brigham Young University. The model parameters were optimized over six coal heat-up rates for each coal type. Statistical analyses of the residual sum of squares for the optimized two-reaction model revealed that there was no significant lack of fit of the data as compared to the inherent variability of the data. 4 refs., 9 figs., 1 tab.

31298 (DOE/MC/19301—2036) Coal gasification research studies. Final report, August 20, 1982-November 30, 1984. (Institute of Gas Technology, Chicago, IL (USA)). Nov 1985. Contract AC21-82MC19301. 323p. NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE86001073.

The Coal Gasification Research Studies program consists of three tasks: (1) coal ash behavior studies; (2) high-pressure fluidization studies, and (3) high-temperature fluidization studies. Some of the highlighs are as follows: A 2-inch-ID fluidized-bed gasifier was used to investigate the formation of ash agglomerates. Gasification of chars from Pittsburgh Seam and Kentucky No. 11 coals established that the rounded particles with a typical agglomerate microstructure of ferrous aluminate crystals in a ferrous aluminosilicate matrix is the result of thermal decomposition and oxidation of pyrite and its reaction with clay minerals. Viscosity measurements were made on several synthetic slag compositions representative of Eastern coal slags and a sample of slag from Black Butte coal over a temperature range of 1600° to 2500°F. On the basis of thermodynamic data, ternary phase diagrams of the iron oxide-silica-alumina system at 0, 5, 10, 15, and 20 weight percent CaO were prepared. In the fluidization studies, computer-assisted pressure probes were developed to experimentally investigate the individual effects of system pressure (up to 450 psig), temperature (up to 180°F), particle size, particle density, bed height, and excess fluidization velocity on bubble properties. The effect of system pressure and particle size on the operation of high-velocity fluidized beds was also investigated using 400, 200, and 100 μm sand up to a maximum pressure of 450 psig. Temperature over the range of 70° to 1800°F had no noticeable effect on bubble size, bubble frequency, and bubble velocity. The bubble size correlation developed from the high-pressure bubble study predicted the high-temperature bubble data to within +-30%. 23 refs., 162 figs., 23 tabs.

31299 **(DOE/MC/21290—2007) Tar removal in a hot gas desulfurization process. Final report, October 1984-March 1985.** Baker, E.G.; Mudge, L.K. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC21-84MC21290. 57p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86001054.

Results of studies from a project sponsored by the Department of Energy (DOE), Morgantown Energy Technology Center (METC), are reported. The primary objective of these studies was to develop a catalyst which converts sulfur in coal tars to a form (such as H_2S) which can be removed by a hot gas desulfurization process being developed by DOE/METC and also converts the tars to compounds that cannot crack and deposit coke on the electrodes of a molten carbonate fuel cell (MCFC). The system for tar destruction would operate in conjunction with the desulfurization process. Results of a literature search and experimental tests are presented. Fifteen different catalysts were evaluated in the experimental tests. The effects of temperature, pressure, and residence time on tar conversion were evaluated. Acid cracking catalysts, in a particular low-sodium type Y zeolite (LZ-Y82) and hydrocracking catalysts based on Y-zeolite, were superior to other catalysts tested. In four hour screening tests, average tar conversions with these catalysts for four different tar samples ranged from 65 to 75% based on total tar. Average sulfur conversion ranged from 86 to 90%. Results of regeneration tests are presented. These tests show that LZ-Y82 is regenerable under mild regeneration conditions. The rate of permanent loss of catalyst activity was too low to identify in the regeneration tests. Catalyst makeup rates based on literature values are presented for estimation of catalyst costs. 30 refs., 14 figs., 26 tabs.

31300 **(DOE/MC/21385—2021) Catalytic cracking of aromatic hydrocarbons. Final report, October 1984-March 1986.** Simons, G.A.; Ham, D.O.; Moniz, G.A. (Physical Sciences, Inc., Andover, MA (USA)). Apr 1986. Contract AC21-84MC21385. 61p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86001056.

Iron containing minerals and chars were screened as cracking catalysts for aromatic hydrocarbons (AHC) in simulated gasifier effluents. Catalytic activities of six minerals and two chars were measured and used to infer fundamental hetereogeneous rate constants using measured properties of the pore structure of the solids. Measurements were made for 200 ppM and 2000 ppM benzene cracking over the temperature range 400 to 1000°C. The active catalyst under gasifier conditions was found to be FeO. The minerals have a higher reactivity per unit mass in chars than in a pure form. H_2S was found to reduce the catalytic activity to one third of the unpoisoned value, but the catalysts maintained this reduced activity. These minerals have the potential to be economically feasible, disposable catalysts in a fixed bed or fluidized bed process if they can survive for ten hours. 8 refs., 33 figs., 3 tabs.

31301 **(DOE/METC—86/0226) Advanced gasification projects. Technology status report.** (USDOE Morgantown Energy Technology Center, WV). Nov 1985. 61p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86001023.

This overview report, covering the period October 1, 1983, to September 30, 1984, prepared by Morgantown Energy Technology Center staff, describes the current status of advanced gasification projects with summary descriptions of individual projects. Furthermore, each project's influence on current emerging gasification programs is assessed. Program accomplishments are described under the following four headings: (1) novel gasification concepts, chemistries, and processes; (2) fundamental concepts; (3) gas stream processing; and (4) fluid dynamics/modeling. 59 refs., 4 tabs.

31302 (DOE/METC—86/6036-Vol.2, pp 357-365) **ChemCoal process for the chemical transformation of low rank coal.** Porter, C.R.; Kaesz, H.D. (Carbon Resources, Inc.). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

The ChemCoal process for the removal of ash and sulfur from low rank coal is under development. The process yields a high Btu solid and distillable liquids by chemical transformation of coal under mild conditions (608°K, 10.4 MPa). Processing steps include liquefaction, separation of solids by centrifugation and filtration, removal of alkali by liquid extraction, and recovery of recycle solvent by distillation. Chemical transformation involves the reactions of coal, alkali, carbon monoxide, water, and phenolic solvent. The preferred form of alkali is Trona (a natural sesquicarbonate Na_2CO_3 x $NaHCO_3$ x $2H_2O$). Synthetic recycle solvent and start-up solvent has for the most part been meta-cresol. Gas chromatography analyses of the solvent from recycle experiments indicate slight changes in solvent composition with a net solvent make. The initial liquefaction step has been tested with several feedstocks and, based upon THF solubility, the DMMF yields were 85.2 to 96.7 wt %. Products from these tests were generated by a series of batch processing steps. The coals were treated at temperature and pressure in a batch reactor and the products filtered in a Buchner funnel. The alkali metal in the filtrate was removed by liquid extraction into an aqueous acid phase. Acids used for the extraction were hydrochloric, carbonic, or formic. The resulting organic phase was distilled to recover recycle solvent, distillable liquids, and a solid. The ChemCoal solid has consistently contained less than 0.3 wt % sulfur and less than 0.3 wt % ash. The ChemCoal product is solid at room temperature, melts at 423°K, and flows freely at 473°K. A burning profile of the ChemCoal solid determined by derivative thermogravimetric analysis indicates that the ChemCoal solid would have similar combustion properties to a high volatile bituminous coal and should burn more readily than a Solvent Refined Coal. 13 refs., 3 tabs.

31303 (DOE/METC—86/6036-Vol.2, pp 366-383) **Study of low rank coals: effect of drying on liquefaction.** Silver, H.F.; Frazee, W.S. (Univ. of Wyoming, Laramie). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

A study of the effect of drying subbituminous Clovis Point coal in air, N_2 and liquefaction solvent has been conducted at the University of Wyoming. All attempts to dry this coal reduced its reactivity, as measured by unreacted coal yields and C_4-850°F distillate yields. Both drying times and temperatures appear to be important variables effecting the reactivity of dried subbituminous coal. Further experiments in which distilled water and Fe_2O_3/dimethyl disulfide were added individually and in combination to the dried coal-solvent reactor feed before liquefaction showed that coal reactivity lost during drying could be recovered. 4 refs., 9 figs., 6 tabs.

31304 (DOE/METC—86/6036-Vol.2, pp 384-402) **Lumping of chemical species in coal liquids using size exclusion chromatography-gas chromatography (SEC-GC) data.** Philip, C.V.; Moore, P.K.; Anthony, R.G. (Texas A & M Univ., College Station). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2). Contract AC18-83FC10601.

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

Relatively large samples (100 mg) of coal liquids and recycle solvents are separated by size exclusion chromatography (SEC) using a 5 μm 100 A PL Gel column (7.8 mm id x 60 cm l) additive-free tetrahydrofuran (THF) as the mobile liquid phase. The fractions separated by SEC are collected by a multisample loop valve. The multiloop valve links the liquid chromatograph with a high resolution gas chromatographic (GC) system equipped with a wide bore fused silica capillary column (bonded phase), a flame ionization detector (FID), and a nitrogen specific detector (TSD). The SEC separates coal liquids into fractions containing species with similar linear molecular sizes. Since similar molecular size species in coal liquid happened to have similar functionalities, the size separation enables the separation of fractions containing similar chemical species. When THF is used as the mobile phase the coal liquid is separated into fractions containing nonvolatiles, long chain alkanes and asphaltenes (nonvolatile THF solubles), phenols and aromatics. The results of SEC-GC analysis of coal liquids indicate that the coal liquids are composed of a very large number of species but with similar structural blocks and functional groups. Lumping of similar components into four distinct groups such as nonvolatiles,

alkanes (nonaromatic hydrocarbons), alkylated phenols and aromatics could be seen as practical means of characterizing coal liquids. The paper discusses the instrumentation, analysis of coal liquid samples, including recycle solvents, and the use of the SEC-GC data to achieve chemical species lumping for coal liquids and recycle solvents. 21 refs., 14 figs.

31305 (DOE/METC—86/6036-Vol.2, pp 403-420) **Cogeneration of electricity and synthetic liquids via hydropyrolysis of Alberta's subbituminous coals.** Chambers, A.K.; Knill, K.J.; Mendiuk, J.J.; Ungarian, D.E. (Devon Coal Research Centre, Alberta, Canada). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

Alberta's subbituminous coals have been evaluated in flash pyrolysis and hydropyrolysis processes on three experimental units; an entrained-flow atmospheric pressure unit (10 gm/hr), a captive-sample heated screen unit (10 mg) and an entrained-flow high pressure unit (2 kg/hr). Combustion properties of char were studied on an entrained flow combustor (60 gm/hr). No significant variability in yield of liquid hydrocarbons was noted among the seven coal fields tested. Pyrolysis gave 14 to 17% daf coal conversion to phenolic, aromatic tars. Under hydropyrolysis conditions, up to 10% daf coal could be converted to benzene with char, methane, ethane, carbon monoxide and water as the other products. Char combustion properties were dependent on process conditions. Some chars may burn better than the parent coal. 8 refs., 11 figs.

31306 (DOE/METC—86/6036-Vol.2, pp 421-434) **Low temperature aqueous alkaline liquefaction of Texas lignite.** Fischer, P.E.; Ouyang, W.; Shah, R. (Texas Tech Univ., Lubbock). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

Small particles of Texas lignite, Wilcox formation were reacted with 0.5 and 0.25 normal solutions of sodium hydroxide in a 2-liter batch reactor. The reaction times varied from 1 to 8 hours and were carried under an inert autogenous pressure. Temperature levels of 100, 130 and 160°C were used. Maximum conversion levels of around 75 to 90% were discovered for these temperature-time combinations. The behavior of the kinetic data for this reaction system pointed to a two-step mechanism for the thermal dissolution of the lignite. A special numerical technique was developed to retrieve the best set of kinetic parameters, for simplified two-step reaction models, that can represent the experimental data. For the first reaction, an activation energy of around 3000 kcal/mole was found for both a first order and second order model, showing some type of diffusion-controlled reaction or the breakage of very weak bonds. The latter hypothesis was selected because the product extracted was found to be soluble in organic solvents in which the original coal was not soluble. Pre-asphaltene yields of up to 25% weight fraction from the soluble fraction were reported. The second step of the reaction has an activation energy of around 16,000 kcal/mole that will represent the reaction of the soluble material back to insolubles. Higher extraction yields and pre-asphaltene production were reported for the higher alkaline concentration, indicating a direct correlation between ionic strength and amount of lignite reacted. The results presented in this report validate the concept of the use of alkaline solutions as the optimal solvent for in-situ lignite liquefaction due to their high extraction yields, low severity operating conditions and the low cost solvent used. 25 refs., 12 figs.

31307 (DOE/METC—86/6036-Vol.2, pp 435-442) **Charring principal isolated from two American lignites.** Garcia, J.M. III; Zingaro, R.A.; Macfarlane, R.D.; Zoeller, J.H. Jr. (Texas A & M Univ., College Station). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

Dimethyl sulfoxide extracts of Wilcox and Gascoyne seam lignites were fractionated into DMSO-soluble, THF-insoluble antiasphaltenes; an asphaltene-preasphaltene fraction soluble in THF but insoluble in hexane; and hexane-soluble bitumen. In both sets of solvent fractions, the antiasphaltenes exhibit a high fixed carbon value and low H/C ratio compared to the DMSO-insoluble or THF-soluble fractions. Both bitumen samples are highly aliphatic and heat sensitive. The solvent fractions were degraded using the pertrifluoroactic acid reagent, and their methyl esters were studied by proton NMR. Integration of the aromatic, aliphatic and carbomethoxy protons indicates a much higher population of aromatic functionalities in the antiasphaltene product than is present in any of the other fractions. Californium-252 Plasma Desorption Mass Spectrometry spectra of portions of the DMSO-soluble matter from Wilcox lignite shows a group of ions of mass periodicity 28 amu in the region from 1061 to 1201 amu. The morphology of the positive and negative ions indicates that they are parent ions from a family of homologous alkyl phenols.

31308 (DOE/METC—86/6036-Vol.2, pp 443-469) **Use of non-coal-derived heavy solvents in direct liquefaction of Wyodak coal.** Miller, R.L. (Univ. of Wyoming, Laramie). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

Results from an exploratory experimental study of liquefaction co-processing using Wyodak subbituminous coal and six non-coal-derived heavy oil samples are reported. The data suggest that relatively high C_4-850°F distillate yields and pyridine soluble coal conversion values can be achieved even at the mild liquefaction reaction conditions used in this work. An apparent synergism towards distillate production is noted when coal and heavy oil are converted simultaneously. This synergism is attributed to increased heavy oil reactivity in the presence of coal. However, only small amounts of coal (2 to 5 wt % of total coal/heavy oil feed) are required for the enhanced reactivity to contribute to overall process improvement. Results from two four-factor experimental designs demonstrate that gas atmosphere, distillate solvent composition and hydrogen donor ability, and use of a disposable catalyst each affect distillate yield and pyridine coal conversion at the reaction conditions studied. Properties of the feed heavy oil also affect liquefaction co-processing performance. The largest C_4-850°F distillate yields (>50 wt % MAF coal basis) were obtained using a mid-continental petroleum 850°F+ residuum sample and a mildly hydrotreated shale oil sample. 44 refs., 15 figs., 8 tabs.

31309 **(DOE/PC/60054—T10) Coal liquefaction. Investigation of reactor performance, role of catalysts and PCT properties. Quarterly progress report, January 1-March 31, 1986.** Shah, Y.T.; Tierney, J.W.; Wender, I.; Joseph, S.; Wen, C.S. (Pittsburgh Univ., PA (USA)). 1986. Contract FG22-83PC60054. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010350.

During this reporting period, studies were focussed on modeling of coal liquefaction processes, and role of catalysts in direct coal liquefaction. The objective of modeling studies is to develop computer simulations which can be used to evaluate the performance of slurry reactors used for direct and indirect coal liquefaction processes. These programs are being written in Fortran language and are designed to be interactive in nature and easily adapted to use in the ASPEN simulator. In the last quarter a literature search was conducted for two stage liquefaction processes, concentrating on the second stage which consists of an ebullated bed reactor. The Wilsonville Integrated Two Stage Liquefaction process is a typical candidate for modeling of Two Stage Liquefaction processes. A brief summary of the review and a kinetic model are presented in this report. Progress in the ASPEN modeling is also reported. For the study on the role of catalysts in coal liquefaction, the objective is to review and discuss key advances in direct coal liquefaction catalysis, especially for the innovative use of certain catalysts in direct coal liquefaction. Among the catalyst systems to be reviewed and whose potentials are to be evaluated are: the use of liquid clathrate systems, homogeneous catalysts such as metal carbonyls and transition metal complexes, germanium and tin salts, iodine and hydrogen iodide, Lewis acids such as $ZnCl_2$ and $AlCl_3$, hydrogen fluoride, and superacids such as fluorosulfonic acid and the less corrosive solid acids such as Fe_2O_3-SO_4^{2-} and TiO_2-SO_4^{2-}. 8 refs., 2 figs., 3 tabs. (AT)

31310 **(DOE/PC/60813—11) Hydrotreatment catalyst activity enhancement. Quarterly report No. 11, February 1-April 30, 1986.** Seapan, M.; Crynes, B.L. (Oklahoma State Univ., Stillwater (USA). School of Chemical Engineering). May 1986. Contract FG22-83PC60813. 52p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86010635.

Chromatographic analysis results of twenty-one model compound hydrogenation runs are presented. The effect of titanocene dichloride on conversion depends on the extent of catalyst presulfidation. The coke content of catalyst in the runs with titanocene dichloride are much lower than the ones without titanocene dichloride when the feedstock is Tetralin and the catalyst is Ni-Mo/alumina. Catalyst presulfidation procedures also affect coke content on the catalyst. The catalyst which is presulfided under more severe conditions has less coke formed on it. When the feedstock is changed to the mixture of decalin, quinoline, methyl isobutyl ketone and carbon disulfide, the same coke content reduction effect is shown only on the Co-Mo/alumina catalyst. For the Ni-Mo/alumina catalyst, the coke contents on the catalysts are not significantly different for the runs with and without titanocene dichloride. In six noncatalytic runs, the formation of free radicals in SRC-II middle distillate at different temperatures were also measured. 5 refs., 30 tabs.

31311 **(DOE/PC/71257—T6) Novel experimental studies for coal liquefaction. Quarterly progress report, January 1-March 31, 1986.** Holder, G.; Shah, Y.T.; Tierney, J.W. (Pittsburgh Univ., PA (USA)). 1986. Contract FG22-84PC71257. 23p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010326.

Accomplishments are presented for the following two tasks: (1) thermal behavior of slurry reactors used for indirect liquefaction; and (2) coal liquefaction under supercritical conditions. For task one experimental procedure for the hydrogenolysis of methyl formats using a Cu-Cr catalyst and summary of the data obtained are presented. The objective for task two is to measure mass transfer rates for naphthalene extraction by carbon dioxide in order to determine how mass transfer coefficients vary with pressure, flow rate and bed height. These parameters will influence the design of extraction or reaction processes which utilize supercritical fluids. A review of mass transfer/equilibrium under supercritical conditions, design and construction of experimental apparatus and calculation of mass transfer coefficients are presented. 12 refs., 6 figs., 3 tabs.

31312 **(DOE/PC/80023—T4) Development of an in-situ hydrogen measuring instrument for coal liquefaction processes. Quarterly report, January-March 1986.** Klinzing, G.E. (Pittsburgh Univ., PA (USA). Dept. of Chemical and Petroleum Engineering). 1986. Contract AC22-85PC80023. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010447.

This three-month period involved the testing of the Microflowmeter that is installed at the University, the final drawings for the container boxes (for Wilsonville), the beginning of the container boxes construction, details concerning the information required by the computer for the control program, and finally, the taking of some preliminary data at the University. 1 fig.

31313 **(DOE/PC/80512—T4) Anaerobic SBR treatment of coal conversion wastewaters. Second quarterly report.** Ketchum, L.H. Jr. (Notre Dame Univ., IN (USA). Dept. of Civil Engineering). 4 Apr 1986. Contract FG22-85PC80512. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86008698.

Development of both an operating strategy and a basis of design for Anaerobic Sequencing Batch Reactor (AnSBR) systems for treatment of coal conversion wastewaters is reported for two different systems: to develop a settleable granular sludge, typical of Anaerobic Up-Flow Sludge Blanket Reactors; and a treatment without developing granular sludges. In the second case, development of more elaborate solids-liquid-gas separation systems may be required. Acclimation studies continue to develop anaerobic sludges better acclimated to treatment constituents common in coal conversion wastewater. Screening studies, in 100 mL to 500 mL serum-bottles, are being conducted to determine treatability and where possible, identify degradation rates and pathways of these coal conversion wastewater constituents, commonly, phenol, aniline, o-cresol, m-cresol, p-cresol, ammonia nitrogen, volatile acids, cyanide, thiocyanide, and xylenes.

31314 **(DOE/PC/80520—T2) Studies on the reaction of calcined limestone with sulfur dioxide. Technical progress report, January-March 1986.** Sotirchos, S.V. (Rochester Univ., NY (USA). Dept. of Chemical Engineering). Apr 1986. Contract FG22-85PC80520. 24p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86009838.

The primary objective of the project is the investigation of the reaction of calcined limestone with SO_2 with particular attention paid to the effects of the pore structure properties and of the intraparticle diffusion process on the sorptive capacity of the reacting limestone particles. During the first quarter of the 1986 calendar year, our research efforts primarily focused on development of structural models for gas-solid reactions with solid product and reactivity evolution studies. Major results are summarized.

31315 **(DOE/PC/80912—T2) Ambient temperature liquefaction using liquid clathrates. Second quarterly report, January 15-April 14, 1986.** Atwood, J.L. (Alabama Univ., University (USA). Dept. of Chemistry). 1986. Contract FG22-85PC80912. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010361.

One of the more significant advances during the last quarter were observations which lead to an enhanced understanding of the basic liquid clathrate itself. This is a particularly relevant point because there is significant agreement that we can never reach full utility for liquid clathrates in coal liquefaction until we fully understand the liquid clathrate effect. It is well known that liquid clathrates form with a variety of aromatic solvents. Early on we attempted to make a liquid clathrate with 1-methylnaphthalene. This was a desirable choice because of the presence of the aromatic rings which seem to mimic some of the products found in work-ups of more classic coal liquefaction experiments. However, to our surprise 1-methylnaphthalene reacts with liquid clathrate-forming salts to yield a pure one-phase solution. In the course of a detailed examination of this phenomenon, we carried out experiments with 1-methylnaphthalene/toluene mixtures. A variety of different concentrations were utilized. The ones of greatest importance are 20% toluene, 80% 1-methylnaphthalene, 50-50, and 80-20. All of these form liquid clathrates. The ones which have the most toluene form liquid clathrates at room temperature. The one with the least toluene forms a liquid clathrate only at low temperature. For each concentration in the range given above there is a critical change from one phase to two phase behavior with temperature.

31316 **(DOE/PC/81201—T2) Microbial removal of organic sulfur from coal. Second quarterly report, January-March 1986.** Fannin, K.F.; Conrad, J.R.; Maka, A. (Institute of Gas Technology, Chicago, IL (USA)). Apr 1986. Contract AC22-85PC81201. 7p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010610.

The specific objectives of the project are: (1) to improve or develop inocula from previous enrichment studies and from a coal storage area soil on model sulfur compounds under aerobic and anaerobic conditions; (2) to determine the effects of process conditions on the efficiencies and rates of the microbiological removal of organic sulfur from coal; and (3) to develop a conceptual process design and perform an economic evaluation of the proposed design. Twelve aerobic enrichment cultures capable of degrading dibenzothiophene (DBT) and thiophene model organic sulfur compounds have been developed and selected. The experiments conducted with the enriched cultures suggest that DBT serves as a sulfur but not as a carbon source for these cultures. Preliminary data demonstrated DBT degradation efficiency as high as 98% in 48-hour cultures. The cultures consist of mixed populations of heterogeneous bacteria.

31317 **(EUR—10068-EN) Mathematical model for the determination of thermal spalling in refractory material on basis of the practical relationship of the appearance of rupture, physical properties and physical conditions.** (Commission of the European Communities, Luxembourg). 1985. 133p. European Community Information Service, 2100 M St., NW, Suite 707, Washington, DC 20057.

Report on ECSC contract 7220-EB/603.

Finite element calculation methods have been applied to the study of the spalling behaviour of refractory materials. The method has been adjusted and tested. Simulative tests and mathematical calculations are executed in parallel to aid evaluation of model calculation results. Material properties are used for the model calculations. Statistical analysis showed that the determination of the elastic properties required improvement and so a new high-temperature deformation measuring device has been developed. Tests were done to record the elastic behaviour in such a way that the results could be combined in a stress-strain diagram which shows the difference between tensile conditions. A computer program has been implemented into the FEM sequence to realize a physically correct calculation. The results of the calculations were in good agreement with the simulation tests except for a systematic deviation. The final model has been applied to an industrial situation at the Ijmuiden coke oven II. This has resulted in the replacement of part of the construction (silica) by another material. (31 refs.)

31318 **(EUR—10091-EN) Refining of coal oils to produce transport fuels and feedstocks.** (Commission of the European Communities, Luxembourg). 1985. 60p. European Community Information Service, 2100 M St., NW, Suite 707, Washington, DC 20057.

Report on ECSC contract 7220-EC/825.

Methods for the conversion of coal liquefaction light distillates to transport fuels have been examined, and the quality of the fuels has been assessed. The light distillate feedstocks were derived from Point of Ayr coal by means of the liquid solvent extraction (LSE) process operated at a number of different conditions. Hydrotreating and reforming of the 180 C- naphtha fraction were successfully accomplished, and a number of catalysts were evaluated. Three samples of gasoline were prepared which were tested in current production cars and each gave satisfactory perfomance. A means of producing low-benzene low-lead gasoline was developed. The 180 C+ mid-distillate fraction was hydrogenated to produce diesel fuel. Development of the method led to a means of effecting the hydrogenation at a lower pressure. One diesel fuel sample, fractionated to exclude the 200 C- material and incorporating an ignition improver, had a cetane number of 50 and was tested in a current production car. Satisfactory results were obtained. The 180-200 C fraction of the hydrogenated mid-distillate was assessed as a jet fuel. Combustion tests carried out on this and on petroleum-derived jet fuel. Combustion tests carried out on this and on petroleum-derived jet fuels indicated that performance correlated best with hydrogen content. Analysis of this and other hydrogenated mid-distillate fractions showed that their hydrogen contents fell just short of the present Jet Al requirement, and other means for improving the quality of this material need to be investigated. Laboratory tests have shown that hydrogenated mid-distillate can be converted to gasoline by catalytic cracking or by catalytic hydrocracking, the octane rating of the product being somewhat higher in the former case. (5 refs.)

31319 **(FE—1207-69(Vol.1)) Gas generator research and development BI-GAS process. Final report for August 19, 1971-October 31, 1979. Vol. 1.** (SEE CODE- 9520811 Bituminous Coal Research, Inc., Monroeville, PA (USA)). Jun 1980. 285p. NTIS.

In support of research and development work on the BI-GAS coal-gasification process, BCR conducted bench-scale and PEDU (process and equipment development unit) studies to develop a fluidized-bed methanation process for use in upgrading the coal-derived synthesis gas. The bench-scale investigations studied catalysts under conditions imposed by the BI-GAS process: high carbon monoxide concentration, high pressure, and a 3:1 hydrogen/carbon monoxide ratio. The PEDU, a 6-in.-diam reactor designed for 6000 SCF/hr flows of gas ($CO + H_2$), generated process data applicable to BI-GAS pilot-plant operations. Utilizing the experience accumulated in laboratory and PEDU research, BCR assisted in the planning, acquisition, and assessment of pilot-plant operation data.

31320 **(FE—1207-69(Vol.2)) Gas generator research and development BI-GAS process. Final report for August 19, 1971-October 31, 1979. Vol. 2.** (SEE CODE- 9520811 Bituminous Coal Research, Inc., Monroeville, PA (USA)). Jun 1980. 569p. NTIS.

Initial operations at the BI-GAS pilot plant began in August 1976 with as-received subbituminous coal from the Rosebud seam in Montana. As reported earlier, base-condition tests revealed an unreliable gasifier-temperature measurement system and problems with the solids-flow measurement equipment. Subsequent tests disclosed problems in maintaining continuous slag tapping, removing slag from the gasifier's quench section, and obtaining a good material balance. Ensuing runs, modified to alleviate these problems, ended when a materials failure due to stress corrosion cracking caused a char burner to rupture. Final recommendations for further work on the BI-GAS process suggest (1) making a comprehensive safety audit of the plant and the process, (2) redesigning the char burners to eliminate plugging tendencies, and (3) establishing a program for the development of high-temperature thermocouples.

31321 **(ORNL/TM—9806) Fixed-film, fluidized-bed bioreactors for biooxidation of coal conversion wastewaters. Progress report, October 1, 1984-September 30, 1985.** Donaldson, T.L.; Strandberg, G.W.; Worden, R.M. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010000.

The technical feasibility of biooxidation treatment of 50% strength actual wastewater was successfully demonstrated using a fluidized-bed bioreactor. The wastewater was stripped to remove ammonia and sulfides prior to biotreatment. Additional experimental and modeling work confirmed the need to supply substantial oxygen to maintain high reaction rates. The reaction kinetics were shown to depend on the physical characteristics of the biofilms. Dynamic modeling and experimental studies have shown that classical reaction and diffusion concepts used in catalysis are adequate to describe the dynamic behavior of bench-scale bioreactors when the pH is constant. Oscillations in the reaction rate and phenol concentration were seen when the pH was not controlled. A status summary of the fluidized-bed bioreactor process for biooxidation of organics in coal gasification wastewaters is presented.

31322 **(PB—86-157872/XAB) Mathematical modeling of emissions from cooling towers using coal gasification wastewater. Final report, November 1982-April 1985.** Green, D.A.; Leese, K.E.; McMichael, W.J. (Research Triangle Inst., Durham, NC (USA)). Aug 1985. 156p. (RTI—2518-01F). NTIS, PC A08/MF A01.

A computer program was developed which predicts the fate of contaminants that may be present in cooling water at coal-gasification plants. Species of high volatility relative to water, such as acetone, methanol, and acetonitrile are predicted to be essentially completely air stripped under typical cooling-tower operating conditions in spite of their biodegradability. Stripping is predicted to be the primary removal mechanism for phenol, a contaminant of slightly higher volatility than water. Two small counterflow cooling-tower systems were operated with simulated treated coal-gasification wastewater in the laboratory to obtain model validation data. The laboratory systems were operated over a range of conditions of temperature, liquid-to-gas ratio, and makeup concentration. These factors were found to be of minor importance to the fractional removal of contaminants. The cycles of concentration, affecting the liquid residence time, is the primary determinant of the fraction of phenol emitted to the atmosphere through air stripping.

31323 **(PB—86-163755/XAB) Coal test program in a pressurized, fluidized-bed ash-agglomerating process development unit. First quarterly report, November 12, 1984-March 30, 1985.** Sandstrom, W.A. (Institute of Gas Technology, Chicago, IL (USA)). Jul 1985. 40p. NTIS, PC A03/MF A01.

The objectives of this program are to obtain an initial data base from a fluidized-bed ash-agglomerating gasifier operating at pressures up to 500 psig on bituminous, subbituminous, and lignite coals. Four gasification tests were conducted with Pittsburgh Seam coal on the 8-inch fluidized-bed process development unit (PDU) at pressures up to 200 psig. A heat and mass balance prepared from gasification data and samples obtained at 100 psig operating pressure show an average ash discharge composition of 80% ash and a coal conversion of 89%. All engineering work is essentially complete and several quotations for equipment were received for upgrading the PDU for operation at pressures to 500 psig. In the next quarter, additional superheat will be added to the process gas supply whereupon tests will be completed with bituminous and initiated with subbituminous coal.

31324 **(PB—86-163763/XAB) Coal test program in a pressurized, fluidized-bed ash-agglomerating process development unit. Second quarterly report, April 1-June 30, 1985.** Sandstrom, W.A. (Institute of Gas Technology, Chicago, IL (USA)). Oct 1985. 68p. NTIS, PC A04/MF A01.

The objectives of this program are to obtain an initial data base from a fluidized-bed ash-agglomerating gasifier operating at pressures up to 500 psig on bituminous, subbituminous, and lignite coals. Four gasification tests have been completed, one each with Pittsburgh Seam, Kentucky No. 9 bituminous, and two with Rosebud subbituminous coal. Heat and mass balances were prepared from gasification data on Rosebud coal at 96 and 195 psig operating pressures and show coal conversions of 92% and 91%, respectively. PDU process system improvements completed this quarter include the installation of: Magnets to remove storage hopper rust contamination of the coal feed, and superheater insulation to raise process steam superheat by 300F . In the next quarter, test work will be completed for obtaining steady-state data on subbituminous and lignite coals at 100, 200, and 300 psig reactor pressure.

31325 **Power recovery system for coal liquefaction process.** Horton, J.R. (to Dept. of Energy). US Patent 4,549,954. 29 Oct 1985. Filed date 24 Apr 1981. vp.

PAT-APPL-257032.

Method and apparatus for minimizing energy required to inject reactant such as coal-oil slurry into a reaction vessel, using high pressure effluent from the latter to displace the reactant from a containment vessel into the reaction vessel with assistance of low pressure pump. Effluent is degassed in the containment vessel, and a heel of the degassed effluent is maintained between incoming effluent and reactant in the containment vessel.

31326 **US coal liquefaction program.** Torkos, T.M.; Lacey, J.J.; Strakey, J.P. (Dept. of Energy, Pittsburgh, PA). *Energy Technology (Washington, D.C.);* **12**: 1473-1486(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The US government's complete strategy for commercializing coal liquefaction includes financial assistance for qualifying coal liquefaction projects through an independent federal entity, the US Synthetic Fuels Corporation (SFC), to private developers of commercial projects under the authority of the Energy Security Act. This potential financial assistance, along with direct technical assistance, serves to reduce overall risks both to first-of-a-kind pioneer synfuels projects and potentially to the nation itself. The authors describe the status of the technology, the needed improvements, strategies, current program activities, new initiatives, and a funding summary for each liquefaction method. An appendix identifies active US projects in the program. 3 figures.

31327 **Production and utilization of coal water fuels.** Brown, N.D.; Passman, R.A. (Atlantic Research Corp., Alexandria, VA). *Energy Technology (Washington, D.C.);* **12**: 1133-1149(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The Atlantic Research Corporation (ARC) coal-water fuel (CWF) programs cover all aspects of fuel processing and use, and range from laboratory to utility scale. They are aimed at successful mid-80s commercialization and at the second generation fueler/user plants of the 90s. The successful production, transport, and combustion of CWF in commercial equipment confirms the readiness of the technology for a wide range of commercial applications. A number of tests could extend the market even farther. The authors review the history of ARC-COAL development, noting the support of the Electric Power Research Institute, DOE, users, and suppliers in promoting commercialization. They note that conversions will yield users net cost savings even at the current depressed oil prices. Industry's desire for stable and secure energy supplies will provide the final impetus to drive the technology to commercial status. 8 references, 10 figures.

31328 **Extending the gasification program research and development/industrial dollar through joint government/industry funding.** Miller, C.L.; Woodcock, K.E. (Dept. of Energy, Washington, DC). *Energy Technology (Washington, D.C.);* **12**: 1378-1388(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Cost sharing between the government and industry in research and development (R and D) programs increases the availability of funds, reduces costs, leads to technology transfers, and provides program focus and relevancy. Joint funding has become an established practice for other research organizations as well. The authors examine the evolution of joint funding into either an implied or explicit policy for pursuing gasification program R and D dollars. They show that the leveraging of funding through cost sharing ensures that technological advances indicated by earlier research programs are translated into commercial successes on a timely basis, and that the additional development efforts required to further improve the technology for converting coal to useful products will be made. 2 figures, 2 tables.

31329 **Small angle X-ray investigations of char structure during gasification.** Foster, M.; Jensen, K.F. New York, NY; American Institute of Chemical Engineers (1985). 22p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract FG22-82PC50806.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Both a pure microporous carbon, Carbosieve-S, and an anthracite coal (PSOC 870) have been studied with small angle x-ray scattering (SAXS) to elucidate the changes in porous structure during gasification. The pure carbon contains an extensive microporosity of very small pores (characteristic size scale -5A) which grow in size and coalesce with gasification. The unconverted anthracite also contains microporosity, but it is neither so large or as extensive as that in the pure carbon. However, the microporosity grows in extent and size rapidly during pyrolysis, the initial stages of char gasification. A random cell model of the porous structure provides statistical information from the x-ray scattering data. The model structure is consistent with the structure of the real pore space and is also useful in predicting effective transport coefficients and gasification rates.

31330 **Coal liquefaction with supercritical ammonia and amines.** Chen, W.Y.; Kazimi, F. New York, NY; American Institute of Chemical Engineers (1985). 40p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC22-83PC60046.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

The extraordinary high efficiency of coal liquefaction with nucleophilic nitrogen-containing solvents was recently demonstrated. Based on solubility and mass transfer considerations, liquefaction at supercritical solvent conditions has also drawn attention. The present study combines these two approaches by exploring the potential of supercritical liquefaction of coal with low molecular weight nitrogen-containing solvents. The first year study has already indicated that these solvents are very effective in converting coal to soluble materials and this concept has potential as a significant approach to low severity coal liquefaction. It has been observed that liquefaction efficiency increases progressively with a specific and identifiable property of these nitrogen containing sol-

vents and that process optimization capitalizing on this property has resulted in 100 percent conversions at mild (275°C) conditions and low solvent to coal ratios. For example, at 275°C and with a 1:1 ratio of solvent to North Dakota lignite (by weight), the liquefaction efficiency increases from 17 percent (daf) to 100 percent. Wyodak coal also shows similar conversion. However, Illinois No. 6 coal provides relatively lower, but still strikingly high conversion at such mild conditions. Products were characterized by sequential Soxhlet extractions, vapor pressure osmometry, elemental analysis, ^{1}H NMR, ^{13}C NMR and GC/MS.

31331 **Short-residence=time coal liquefaction.** Longanbach, J.R.; Droege, J.W.; Chauhan, S.P. *ACS Symposium Series;* **24**: No. 2, 52-61(1979).

A parametric study of the Mobil Research & Development Corp. two-step coal liquefaction process suggested potential hydrogen savings compared with the conventional solvent-refined-coal (SRC) process due to the short contact times and the removal of mineral matter and sulfur after the first stage, before the addition of hydrogen. In step one, carried on in an autoclave at 413°-454°C, 300-1800 psi, solvent-coal ratios of 2:1 or 3:1, and 0-5 min residence time, West Kentucky coal (3.16 or 3.75% sulfur) reacted with a recycled solvent from a SRC pilot plant and up to 85% of the coal rapidly converted to a tetrahydrofuran (THF)-soluble product, which was unstable in the absence of hydrogen. In step two, the addition of hydrogen or 25% by wt tetralin to the solvent stabilized coal molecules and increased the THF-soluble conversion, but did not lower the sulfur content unless higher temperatures were used. The average SRC did not meet the current sulfur dioxide emission standards after the first process step. Analysis showed that $\approx$ 1.3% of the solvent hydrogen transfers to coal during liquefaction at a 3:1 solvent-coal ratio.

0105 By-products

REFER ALSO TO CITATION(S) 31458

0106 Properties

REFER ALSO TO CITATION(S) 31304, 31307, 31340, 31355, 31363, 31364

31332 **(DOE/EV/10237—T3) Identification of polycyclic aromatic compounds containing two heteroatoms in coal liquids and shale oils. Incremental funding request and annual progress report, March 1-November 31, 1983.** Lee, M.L.; Castle, R.N. (Brigham Young Univ., Provo, UT (USA). Dept. of Chemistry; University of South Florida, Tampa (USA). Dept. of Chemistry). 1983. Contract AC02-79EV10237. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010367.

The synthesis of 37 thiophenes, 17 dithiophenes, and 19 other nitrogen-, sulfur-, and oxygen-containing bifunctional PAC have been completed. The thiophenes are being used for the continued determination of sulfur heterocycles in synfuels, while the latter are being used for screening synfuel fractions for these new classes of compounds. Initial screening indicates the presence of hydroxyphenylthiophenes, hydroxybiphenylthiophenes, hydroxyindoles, hydroxycarbazoles, hydroxyquinolines, hydroxyphenylpyrroles, hydroxyphenylpyridines and aminothiophenes. A supercritical fluid fractionation apparatus has been designed and is being constructed to study the fractionation of synfuel chemical classes using various supercritical fluids. 6 figs.

31333 **(DOE/EV/10244—T5) Field-flow fractionation in the analysis of energy related materials. Progress report, August 1, 1979-January 31, 1983.** Giddings, J.C. (Utah Univ., Salt Lake City (USA). Dept. of Chemistry). Aug 1982. Contract AC02-79EV10244. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010588.

During the contract period nine articles have been prepared and submitted for publication. Specific progress is described in the following four areas: (1) Basic Particle Characterization. The information content of retention and plate height measurements has been summarized and particle sizing from such measurements is evaluated as to accuracy. A comprehensive theory has been developed for the on-column concentration procedure used to analyze dilute suspensions. Progress is also reported for the simultaneous determination of particle size and density, the study of particle-wall interactions, the computer control of sedimentation field strength, and basic FFF methodology. (2) Water Quality and Energy Development. Work has been completed on the development of FFF procedures for the analysis of the colloidal content of river water. (3) Airborne Particulates. Progress has been made in fractionating crushed silica, a model sample for dust. Work has been initiated on the size analysis of fly ash. (4) Coal Liquids and Fine Ground Coal. We have shown that FFF can be used to rule out the presence of colloidal particles in selected coal liquids. Also, FFF can be used to follow the changes in the particulate feed stock for coal liquefaction, suggesting process control application. Finally, a project to characterize fine ground coal by steric FFF has been completed.

31334 **(DOE/PC/60796—10) Reactions governing coal solubilization. Tenth quarterly report, October 15, 1985-January 15, 1986.** Stock, L.M.; Choi, Chol-yoo; Mallya, N. (Chicago Univ., IL (USA). Dept. of Chemistry). 1986. Contract FG22-83PC60796. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010212.

PSOC-1197 has been reduced with large quantities of potassium in ND_3 and quenched with ND_4Cl with the purpose of characterizing the sites of reactions. The deuterium NMR spectrum of the pyridine soluble product suggests cleavage of carbon-carbon bonds and some degree of disproportionation of hydroaromatic structures either native to the coal or formed in the reduction reactions. Results of alkylation and various other reactions of PSOC-1197 in a strongly basic medium suggest that the small degree of alkylation is largely responsible for the high extractability. Effects of various alkylation and reduction reactions on Texas lignite are also described. 17 refs., 4 figs., 3 tabs.

31335 **(EPRI-AP—4536) Wyodak coal: composition, reactions, and products. Final report.** Knudson, C.L. (North Dakota Univ., Grand Forks (USA). Energy Research Center). May 1986. 76p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920266.

Subbituminous coal and other low-rank coals are uniquely different from bituminous coal. In general for low-rank coals, one more analysis is always required before comparisons between coals are attempted. Analyses data for subbituminous coal obtained from a Wyodak seam in Wyoming are presented and discussed. Included are proximate, ultimate, petrographic, pyrolysis, mineral content, ion exchange, and C-13 NMR data. In addition, solid state NMR data of char resulting from pyrolysis at 340°C are compared to the original coal. Considerable changes in oxygen-containing functional groups occurred. The previous data are compared to the yield structure and a ChemCoal product produced at 345°C in phenolic solvent with added sodium and a reducing gas containing carbon monoxide. Conversion was 93% to phenolic-solvent-soluble material. The adduction of phenolic solvent into ChemCoal was similar to the amount of phenols produced from the coal (about 5 to 7 wt % maf coal), resulting in a 99.4% phenolic solvent balance for the condition studied. Net distillate recovery was 103.5 wt %, while the ChemCoal yield was 72 wt % maf coal. 64 refs., 13 figs., 28 tabs.

31336 **(NIPER—108) Thermodynamic properties of real and synthetic fluid mixtures derived from fossil substances. Phase behavior study of hydrogen and 450-950°F coal liquid from a coal liquefaction unit at Wilsonville, Alabama.** Gupta, M.K.; Harrison, R.H.; Vogh, J.W.; Gammon, B.E. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). 14 Oct 1985. Contract FC22-83FE60149. 94p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010657.

Experimental vapor-liquid-equilibrium (VLE) and density data were determined on hydrogen with a 450 to 95o°F boiling range coal liquid at 573.2, 623.2, and 673.2 K and at pressures up to 20.7 MPa. This work was part of an effort to obtain a comprehensive set of physical, chemical, and thermodynamic data on a representative coal liquid. Significant dealkylation and possibly some hydrogenation occurred during measurements on the 673.2 K iso-

therm. Concentrations of light gases in each phase was determined by gas chromatography. The concentration of the heavier components was determined by simulated distillation and by low-voltage, high-resolution, mass-spectral analysis. The Soave modified Redlich-Kwong equation of state was used to test the data when the system was treated as a single component liquid in equilibrium with a single component gas. One temperature dependent interaction parameter was required to represent the data within experimental uncertainty. Additional hydrogen solubility and VLE data were tested. Tentative linear correlations of the interaction parameters as a function of pseudo-critical pressures, pseudo-critical temperatures, and average molecular weights were developed. 18 refs., 21 figs., 25 tabs.

31337 **Photothermal method of determining calorific properties of coal.** Amer, N.M. (to Dept. of Energy). US Patent 4,540,285. 10 Sep 1985. Filed date 16 May 1983. vp. PAT-APPL-495205.

Predetermined amounts of heat are generated within a coal sample by directing pump light pulses of predetermined energy content into a small surface region of the sample. A beam of probe light is directed along the sample surface and deflection of the probe beam from thermally induced changes of index of refraction in the fluid medium adjacent the heated region are detected. Deflection amplitude and the phase lag of the deflection, relative to the initiating pump light pulse, are indicative of the calorific value and the porosity of the sample. The method provides rapid, accurate and non-destructive analysis of the heat producing capabilities of coal samples. In the preferred form, sequences of pump light pulses of increasing durations are directed into the sample at each of a series of minute regions situated along a raster scan path enabling detailed analysis of variations of thermal properties at different areas of the sample and at different depths.

31338 **Fracture toughness testing of coal.** Kirby, G.C.; Mazur, C.J. (Dept. of Mechanical & Aerospace Eng., West Virginia Univ., Morgantown). pp 497-506 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—). Contract AM21-79MC11284.

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

Two commonly used techniques to release trapped methane gas from coal and oil shales are hydraulic fracturing and dynamic fracturing. The first technique cracks open the coal seam by the injection of a pressurized fluid. The second technique makes use of a controlled explosion to generate and extend multiple fractures in an oil or gas formation. In order to control and optimize both of these fracturing processes, it is necessary to predict the onset of crack propagation in the coal seam. One concept commonly used to predict the onset of unstable crack propagation in isotropic materials is the plane strain fracture toughness (K/sub IC/). K/sub IC/ is a material property, and thus is independent of specimen size and crack length. This concept has also been shown to be applicable to anistropic materials (Konish et al. 1972, and Guess et al. 1973). Therefore, the concept of plane strain fracture toughness, which is so widely applied to predict the onset of fracture in engineering materials, may also be useful in predicting the onset of fracture in geological materials such as coal and oil shales. This paper examines fracture toughness values for coal from three different coal seams. The effect of the anisotropic nature of coal on fracture toughness is also studied both experimentally and analytically.

31339 **Effect of pore structure on char oxidation kinetics.** Su, J.L.; Perlmutter, D.D. New York, NY; American Institute of Chemical Engineers (1985). 37p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Prior studies have demonstrated that char gasification rates vary with conversion, showing a maximum at an intermediate level. In this work experimentally determined char-air reaction rates and corresponding pore structures are compared to assess the applicability of a previously proposed random pore model and to extract pertinent chemical and physical parameters. Results on six different chars are presented and analyzed to obtain structure parameters, intrinsic kinetics, and activation energies. Agreement between two independent evaluations of the structure parameters demonstrates the degree of applicability of the random pore model.

0108 Waste Management

REFER ALSO TO CITATION(S) 31313, 31323, 31324, 31373, 31780, 31781, 31783, 31786, 32098, 32178, 32711, 32730

31340 (DOE/METC—86/6036-Vol.2, pp 600-608) **Mineralogy of low rank coal fly ash.** McCarthy, G.J.; Steinwand, S.J. (North Dakota State Univ., Fargo). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

An x-ray diffraction study has been performed on seventy-seven fly ashes from thirty-three power plants. Low rank coal (LRC) mineralogy was characterized by the following crystalline phases: anhydrite, tricalcium aluminate, lime, merwinite, melilite and periclase. Quartz, ferrite spinel (magnetite) and mullite (in subbituminous coals) were also present in LRC fly ashes. A small amount of alkali sulfate phases was observed in many of the lignite-derived ashes. The shift of the broad maximum (in the x-ray background) to larger angles (smaller interplanar spacings) with increasing analytical CaO that was first described by Diamond was confirmed in this study. Quantitative x-ray phase analysis for lime, periclase and quartz was performed on a series of ashes collected from the same power plant over a period of three years. Mineralogy of the ashes is correlated with available chemical analysis data. During the course of this analysis it was noted that the analytical alumina content of the ashes is a good indicator of the rank of the coal from which the ash is derived. 11 refs., 2 figs., 1 tab.

31341 (DOE/METC—86/6036-Vol.2, pp 609-615) **Trace element attenuation characteristics of North Dakota fly ash disposal site sediments.** Hassett, D.J.; Groenewold, G.H. (Univ. of North Dakota, Grand Forks). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

This study involved a series of experiments designed to measure the ability of western North Dakota overburden sediments to attenuate trace elements released from fly ash leachates. These experiments, carried out at various levels of acid and alkali loading, have provided valuable data on the behavior of trace elements which are of major concern in leachates from low-rank coal waste. These data, in conjunction with ongoing field monitoring studies, are providing an objective basis upon which to design disposal sites. 7 refs., 1 fig., 1 tab.

31342 (DOE/METC—86/6036-Vol.2, pp 638-651) **Selection of ash for utilization and economics of ash use in various products.** Manz, O.E.; Mitchell, M.J. (Univ. of North Dakota, Grand Forks). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

A variety of options have been demonstrated or have been suggested for the utilization of coal-derived ash materials. These range from soil stabilization to the recovery of alumina or exotic metals. This paper examines some of these options, includes economics for some of the utilization methodologies, and serves as a general tutorial for matching a fly ash or bottom ash with a proposed use. The requirements for the use of ash in road building are discussed. The specific products discussed include ready-mix concrete for general purpose applications utilizing lignite ash as a direct replacement for portland cement. Fly ash, waste glass, and clay can be used to produce a high-flexural-strength ceramic material. Blended cement can be produced by several methods including slagging fly ash and limestone at over 1400°C to produce a material that is quenched and pulverized. Mineral wool insulation can also be produced from ash. Other applications such as concrete railroad ties, wall and floor tile, and dry-pressed ash brick indicate the eco-

nomic savings and broad potential involved in the use of properly chosen ash. 10 refs., 6 figs., 3 tabs.

31343 **(DOE/PC/80515—1) [Surface science model studies for flue gas cleanup process on CuO and Fe_2O_3]. Technical progress report, September-November 1985.** Grunze, M. (Maine Univ., Orono (USA). Lab. for Surface Science and Technology). 1985. Contract FG22-85PC80515. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009495.

The necessary gases, regulators and substrates have been ordered and have been received. On October 18, the new Leybold Hereeus High Pressure XPS machine (NSF grant DMR-8403831) was installed at the University of Maine and its general performance was tested under UHV conditions. The results indicate that the equipment operates according to its specifications for x-ray photoelectron spectroscopy. During the time period of this report a Cu[111] single crystal surface has been prepared for the project and calibration spectra for Cu^0(Cu[111]), Cu_2O, CuS and $CuSO_4$ have been recorded. Also, a literature search to update the reprints relevant to the program has been carried out. Most of the time, however, was spent on the preparation of the experiments to be conducted under the research program.

31344 **(DOE/PC/80523—T2) Surface and electrochemical studies in coal cleaning. Technical progress report, January 1, 1985-March 31, 1986.** Chander, S.; Aplan, F.F. (Pennsylvania State Univ., University Park (USA)). 1986. Contract FG22-85PC80523. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86009974.

This project is concerned with the development of better ways to remove these sulfur and ash farming minerals from coal prior to combustion. Precombustion cleaning methods include: (a) physical separation processes and (b) chemical treatment methods. Where applicable, physical separation methods are simpler in plant design and operation and are highly cost effective. In these methods the sulfur is removed in its least reactive form. A limitation of physical separation methods is that they are ineffective in removing organic sulfur from coals, thus requiring chemical methods. The chemical coal cleaning methods use various pretreatments and chemical reagents to leach the undesirable constituents which are then separated from the coal by solid/liquid separation methods.

31345 (INIS-mf—9886, pp 24-27) **Coal power stations clean their flue gas - what to do with the residues.** Hoffmann, H.; Stork, W. Jan 1985. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752052.

In State Authority for Water and Waste Management of North-Rhine Westphalia. Annual report '84.

Legal regulations for air pollution abatement cause the problems of waste or waste water removal, because utilization or deposit of flue gas residues has some pollution in its wake. The undesirable salts and heavy metals are found either in waste water or solid waste. Minimising pollution by using the residues seems possible if flue gas desulphurization method are improved in such a way that little or no waste water is caused in the process. Small quantities could be vaporized, residues of this process would have to be deposited on special dumps. Recycling comes in here by substituting natural gypsum by gypsum used for desulphurization of flue gas. (orig./PW).

31346 **(PB—86-159845/XAB) Environmental assessment of a watertube boiler firing a coal-water slurry. Volume 1. Technical results. Final report, January 1984-March 1985.** DeRosier, R.; Waterland, L.R. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Feb 1986. 92p. NTIS, PC A05/MF A01.

The report describes results from field testing a watertube industrial boiler firing a coal/water slurry (CWS) containing about 60% coal. Emission measurements included continuous monitoring of flue-gas emissions; source assessment sampling system (SASS) sampling of the flue-gas, with subsequent analysis of samples to obtain total flue-gas organics in two boiling point ranges, compound category information within these ranges, specific quantitation of the semivolatile organic priority pollutants, and flue-gas concentrations of 73 trace elements: EPA Methods 5/8 sampling for particulate, SO_2, and SO_3 emissions; and grab sampling of fuel and ash for inorganic composition. NOx, SO_2, CO, and TUHC emissions were in the 230-310, 880-960, 170-200, and 1-3 ppm ranges (corrected to 3% 02), respectively, over the two tests performed. Particulate levels at the boiler outlet (upstream of the unit's baghouse) were 7.3 g/dscm in the comprehensive test. Coarse particulate (>3 micrometers) predominated. Total organic emissions were almost 50 mg/dscm, with about 70% of the organic matter in the nonvolatile (>300 C) boiling point range. The bottom ash organic content was 8 mg/g, 80% of which was in the nonvolatile range. Of the PAHs, only naphthalene was detected in the flue gas particulate, with emission levels of 8.6 micrograms/dscm. Several PAHs were found in the bottom ash.

31347 **A molten salt reactor for dispersed solid phase chlorination.** Dobbins, M.S.; Burnet, G. New York, NY; American Institute of Chemical Engineers (1985). 16p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract W-7405-ENG-82.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

A unique reactor system for the high-temperature (400°C-700°C), batch chlorination of finely-divided, mixed metal oxides dispersed in a NaCl-$AlCl_3$ melt is described. Provisions are made for operation under an inert atmosphere and for sampling of the heterogeneous melt and of the mixed metal chloride vapor product stream. Application of the reactor system to mineral recovery from coal conversion solid wastes is underway.

31348 **PED: Pressurized electroosmotic dewatering.** Heath, L.W. Ames, IA; Iowa State Univ. (1985). 109p. University Microfilms Order No. 85-24,662.Contract W-7405-ENG-82.

Thesis (Ph. D.).

The strength of electroosmosis is in its independence of pore size, whereas pressure removes the free water from the larger pores rapidly and causes consolidation to occur. Electroosmosis has no intergranular effects, so consolidation is beneficial to the electroosmotic process in that the pores remain saturated for a longer time, menisci do not form and an induced hydraulic gradient opposing the electroosmotic gradient is not established as soon. The experimental program investigated the optimization of pressurized electroosmotic dewatering (PED) of ultra-fine coal suspensions. The slurry characteristics of greatest interest were the particle size distribution and zeta potential. The particle size distribution controls the maximum packing density and thus, the lowest pore volume, obtainable. A reduction in pore volume increases the degree of saturation for a given quantity of water. The zeta potential of a suspension directly governs the electroosmotic flow rate. A computerized data acquisition system was built to monitor the PED tests. This enhanced the research by allowing more test data to be obtained in a short time and more testing to be completed because of the reduced test analysis time. Also, other suspended materials such as kaolinite slurries, lignite slurries, phosphate slimes, red mud, fly ash scrubber slimes and diamond slimes were tested using PED.The test results provide a basis for pilot-scale testing of PED in a continuous manner. A pilot-scale study will provide process algorithms for economic commercial applications of PED and incorporate full-scale equipment constraints.

0109 Environmental Aspects

REFER ALSO TO CITATION(S) 31376, 32712

31349 **(CONF-8505158—2) Zooplankton community responses to synthetic oil exposure.** Hook, L.A.; Franco, P.J.; Giddings, J.M. (Oak Ridge National Lab., TN (USA)). 1985. Contract AC05-84OR21400. 57p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010038.

From ASTM symposium on community toxicity testing; Colorado Springs, CO, USA (6 May 1985).

The responses of microcosm and pond zooplankton communities to oil treatment were quite similar. Their close agreement lends support for using shallow-water pond microcosms as surrogates for field experiments in hazard evaluation. Changes in clado-

ceran densities were the most sensitive indicators of stress in the zooplankton communities. Copepods were slightly less sensitive, and rotifers were least sensitive to oil treatment. Indirect effects on populations were observed at intermediate treatment levels. The lowest treatment levels at which persistent and significant ecological changes occurred were the same in both systems. These levels were similar to the lowest observed-effect concentration (LOEC) for the Daphnia magna chronic bioassay, or approximately 30% of the D. magna 48-h LC_{50}. Community structure responses were generally consistent between systems; however, sensitivity for detecting oil treatment effects varied greatly among the measures of community structure. Species richness and diversity measures were not as sensitive as individual species responses. Cluster and multivariate post-clustering analyses of community similarity values reflected indirect effects and had sufficient sensitivity to allow early impact detection. An expanded principal components technique, which used both zooplankton and water quality data, was also relatively sensitive and would be applicable for routine monitoring.

0110 Reserves And Exploration

REFER ALSO TO CITATION(S) 31357

31350 (DOE/METC—86/6036-Vol.2, pp 559-588) **Geological, geochemical and hydrological factors affecting the distribution of sodium in lignite in west-central North Dakota.** Fulton, C.S. (Univ. of Kentucky, Lexington). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

In the lignites of the Underwood field, the Na-to-Ca + Mg ratio in groundwater which occurs in lignites determines the sodium distribution in these lignites. Hydrogeologic controls on this ratio include the texture, lithologic composition, and thickness of the overburden. Since sodium exchange in coals occurs under saturated conditions, the position of the water table with respect to the coal is also critical. If conditions change from saturated to unsaturated, the sodium distribution developed in the coal under saturated conditions will be preserved in the unsaturated setting. In general, sodium-rich coals in the Underwood field are associated with low hydraulic conductivity in both overburden and coals with clayey overburden rich in exchangeable sodium. Low concentrations of sodium in the Underwood coals are associated with thin or coarse-textured overburden. 20 refs., 22 figs.

31351 (DOE/METC—86/6036-Vol.2, pp 589-599) **Geochemistry of sodium in North Dakota lignite.** Ting, F.T.C. (West Virginia Univ., Morgantown). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

Sodium is present as exchangeable cations in lignite and its concentration is inversely proportional to calcium cations. The presence and concentrations of the calcium cations in North Dakota lignite appear to be related to the concentration and permeability of the immediate roof rocks - Paleocene sediments or glacial drift. Data obtained from several hundred bore holes indicate good correlation between low sodium content in lignite and the presence of sandy roof rocks. 12 refs., 7 figs., 1 tab.

0120 Mining

REFER ALSO TO CITATION(S) 31338, 31375, 31377, 31378, 31380, 31381, 31441, 31442, 31443, 31444, 31445

31352 (CSIRO-DG-LS—59) **Demonstration of hydraulic fracturing stress measurement techniques.** Enever, J.R.; Wooltorton, B.A. (Commonwealth Scientific and Industrial Research Organization, Mount Waverley (Australia). Div. of Geomechanics). Sep 1984. 58p. Commonwealth Scientific and Industrial Research Organization, Mount Waverly (Australia). Div. of Geomechanics.

The hydraulic fracturing technique provides the only currently available, practically viable method of making an assessment of the magnitude and orientation of the horizontal stress field from the surface, to depths of interest to the coal mining industry. Financial support from NERDDC has allowed CSIRO Division of Geomechanics to develop the technique for specific application in coal measure sediments and develop a technology that promises to have routine application in future underground and deep surface prospects. The report summarises the history of development of the technique under NERDDC sponsorship.

31353 (DOE/METC—86/0233) **Coalbed methane. Technology status report.** (USDOE Morgantown Energy Technology Center, WV). Jan 1986. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86001040.

Coalbed methane research focuses on (1) estimating the extent of the resource with increased accuracy and reliability, (2) estimating the amount of coalbed methane that is recoverable, and (3) providing technically and economically viable means for methane recovery. The goal is to promote extensive private use of the resource as a national energy source. DOE has made significant progress in developing new knowledge, including the following accomplishments: Over 90 well sites have been logged, and over 350 core samples have been taken from these sites for desorption and proximate and ultimate analysis tests to provide insight into gas release mechanisms for various coal ranks. A comprehensive geological assessment was made to estimate the gas-in-place for 16 basins. Twenty production tests were completed to develop guidelines for recovery concepts in different geologic environments. While the project has made significant progress, the development of coalbed methane as a contributing source to the US gas supply has not been widespread. The mixing of unconventional gas with conventional natural gas has been investigated for use by residential, commercial, and industrial customers in space heating, coal drying, and onsite power generation. Recovery concepts must be further developed to quantify risks and to establish the economics of coalbed methane for coal mine operators and other investors. 7 refs., 7 figs., 1 tab.

31354 (PB—86-156163/XAB) **Electrostatic sensitivity, strength, and no-fire current of short-delay detonators. Report of Investigations/1985.** Bajpayee, T.S.; Mainiero, R.J.; Hay, J.E. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1985. 16p. (BM-RI—8989). NTIS, PC A02/MF A01.

The Bureau of Mines evaluated short-delay coal-mine detonators manufactured by three domestic companies for electrostatic sensitivity, strength, and no-fire current level. Electrostatic sensitivity was studied in pin-to-pin and pin-to-case modes employing 10-kV potential. Strength of detonation was measured in the Bureau's underwater test facility. No-fire current was measured using a constant-current power supply unit. Test procedures and experimental data are included.

0130 Transport And Handling

REFER ALSO TO CITATION(S) 31348, 32867

31355 (ACIRL-PR—85-3) **Preliminary investigations into fine coal dense medium cyclone processing.** Graham, C.C.; Lamb, R. (Australian Coal Industry Research Labs. Ltd., North Ryde). Oct 1985. 55p. Australian Coal Industry Research Labs. Ltd., North Ryde.

The beneficiation of coal by dense medium cyclones has achieved a prominent place in the Australian coal industry by virtue of the efficiency and versatility of the process. The process is typically applied to minus 50 mm, plus 0.5 mm coal and is readily adopted to process control for accurate density separations. The role of dense medium rheology in the success of the process is not adequately understood. This report details practical aspects of improving the separation efficiency of dense medium cyclones by control of the rheology of the dense medium. Such control is considered important to the treatment of fine coal of minus 1.0 mm by dense medium cyclones. The results of two surveys of dense medium cyclone installations are reported. Laboratory tests of the effect of contamination and magnetic state on the viscosity of the dense medium are examined. Dynamic stability is investigated by the effect of cyclone geometry and operating conditions on the un-

derflow and overflow density differential and separation efficiency. Guidelines on the control of dense medium rheology are established to maximise dense medium cyclone separation efficiency for coal preparation plants. (11 refs.)

31356 **(DOE/FE/60181—201) Pilot-scale preparation of lignite and subbituminous coal/water fuels.** Potas, T.A.; Baker, G.G.; Maas, D.J.; Farnum, S.A. (North Dakota Univ., Grand Forks (USA). Energy Research Center). 1986. Contract FC21-83FE60181. 15p. (CONF-860548—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010023.

From 8. international symposium on coal slurry fuels preparation and utilization; Orlando, FL, USA (27 May 1986).

The majority of today's coal/water slurry technology has been developed to prepare a high energy liquid fuel from bituminous coals. Low-rank coals, mostly because of their high inherent moisture contents, produce a lower energy density slurry fuel when mixed with water and can not be economically utilized. However, the energy density of low-rank coals in slurry can be dramatically improved with hydrothermal treatment. This process results in the coal being essentially slurried in its own initial moisture and results in a liquid fuel having approximately the same heating value as the parent coal. The elevated temperatures of the process also cause low-rank coals to undergo both chemical and physical changes, which, depending on process severity, may include decarboxylation, mild pyrolysis, extraction, dehydration and surface modification. As a result, lignite and subbituminous coals acquire surface characteristics and improved coal quality which greatly enhance their usefulness in preparing concentrated coal/water slurry fuels. The University of North Dakota Energy Research Center (UNDERC) has been developing a hydrothermal low-rank coal treatment process since 1983. A continuous Process Development Unit (PDU) to produce 2.5 tons of slurry per day has been built and operated to demonstreate the technical feasibility of the process and to generate data useful in engineering and economic studies. Coal/water slurry fuels have been produced from a variety of lignitic and subbituminous coals at concentrations of 58 to 64 wt% bone-dry coal solids loading. These slurries have heating values ranging from 6000 to 8000 Btu/lb. Although stability is very coal specific, some of these slurries (prepared without the use of chemical dispersants) have been stored for over a year without evidence of settling. he properties of low-rank coal/water fuels prepared by the hydrothermal-treatment procedure. 30 refs., 8 figs., 7 tabs.

31357 **(DOE/METC—86/6036-Vol.2) Thirteenth biennial lignite symposium: technology and utilization of low-rank coals proceedings. Volume 2.** Jones, M.L. (ed.). (North Dakota Univ., Grand Forks (USA). Energy Research Center). Feb 1986. 306p. (CONF-850565—Vol.2). NTIS, PC A14/MF A01; 1; GPO Dep. File Number DE86001077.

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

These proceedings are the collected manuscripts from the 1985 Lignite Symposium held at Bismarck, North Dakota on May 21-23, 1985. Sponsorship of the thirteenth biennial meeting was by the United States Department of Energy, the University of North Dakota Energy Research Center, and the Texas University Coal Research Consortium. Seven technical sessions plus two luncheons and a banquet were held during the two and a half day meeting. The final half day included tours of the Great Plains Gasification Plant; Basin Electric's Antelope Valley Power Station; and the Freedom Mine. Sessions covered diverse topics related to the technology and use of low-rank coals including coal development and public policy, combustion, gasification, environmental systems for low-rank coal utilization, liquefaction, beneficiation and coal mining and coal inorganics. All the papers have been entered individually into EDB and ERA.

31358 (DOE/METC—86/6036-Vol.2, pp 470-482) **Technique for upgrading of low-rank coals.** Yamamoto, Akio; Nakamura, Yooichi; Tomuro, Jinichi. (Hitachi, Ltd., Tokyo, Japan). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

We are developing an upgrading process for low-rank coals such as subbituminous coal or lignite, restricted their utilization. This upgrading process consists of four stages of drying, carbonizing at the range of 250 to 450°C, cooling and tar (produced by carbonizing stage) - coating. After several basic and elementary experiments, we constructed a pilot plant for upgrading and tests were carried out using US subbituminous coals. As a result, we confirm that these coals are able to be converted to available fuels and properties of upgraded coals are nearly the same as those of bituminous coals by using this process. Since the main drawbacks of low-rank coals are high moisture content, low heating value and great liability to spontaneous combustion, the upgrading process aims at obtaining the converted high-rank coals with low moisture content, high heating value and small liability to spontaneous combustion. To do this, the low-rank coals are carbonized at relatively low temperature after drying and in consequence the oxygen-containing hydrophilic groups as carboxyl, carbonyl and hydroxide groups, etc., in these coals are heat-decomposed. 1 ref., 14 figs., 1 tab.

31359 (DOE/METC—86/6036-Vol.2, pp 483-495) **Beneficiation processes for ultrafinely ground low rank coals.** Steele, W.G.; Bouchillon, C.W.; Ross, R.B. (Mississippi State Univ., Mississippi State). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

This paper gives the results of research on combined ultrafine grinding and drying of lignite and on ash removal efforts related to this product. Lignite from the Claiborne group in Mississippi was simultaneously ground and dried with either air or steam in a fluid energy mill to an average particle size of seven microns based on volume. Different drying temperatures were used, and the properties of the ground lignite are shown versus grinding medium temperature. These properties include equilibrium moisture, heating value, ash, volatiles, porosity, density, ultimate analysis, and ash mineral analysis. The results of ash removal efforts using an aerodynamic, or size, classification system are also reported. These data show that the ash for this lignite is uniformly distributed throughout the full particle size range making cleaning difficult. 12 refs., 7 figs., 4 tabs.

31360 (DOE/METC—86/6036-Vol.2, pp 496-519) **Production and combustion of hot-water dried low-rank coal slurries.** Sears, R.E.; Baker, G.G.; Maas, D.J.; Potas, T.A.; Patel, R. (Univ. of North Dakota, Grand Forks). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2). Contract FC21-83FE60181.

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

Hydrothermal conditioning, in a water slurry at temperatures above 230°C, is one method which can significantly improve the quality and "slurryability" (bone-dry solids loading and slurry viscosity) of low-rank coals. Hot-water thermal conditioning of lignite and subbituminous coals has been found not only to change both the chemical and physical characteristics of the coal but also alters the coal's slurry rheological properties. These changes result because decarboxylation, mild pyrolysis, extraction, dehydration, and surface modification all occur during hydrothermal treatment. Concentrated low-rank coal/water slurries of >60% bone-dry solids have been achieved with pseudoplastic flow behavior and stability towards settling, without the use of additives. Heating values, on a per unit mass basis, for these slurries were only slightly less than the energy content of the as-mined coal. Chemical modifications and improvement in slurry rheological properties, due to hydrothermal treatment, were greater for lignites and brown coals, and less so for coals of increased rank. A 200 lb/hr Process Development Unit (PDU) has been constructed to demonstrate operability on a continuous basis and to produce slurry for pilot-scale combustion tests. 24 refs., 12 figs., 5 tabs.

31361 (DOE/METC—86/6036-Vol.2, pp 520-542) **Thermal drying of low-rank coals using the fluid-bed method.** Wilver, P.J.; Brumbaugh, C.A. (McNally Pittsburg International Inc., KS; Kennedy Van Saun Corp., Danville, PA). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

A commercial size drying plant employing the principles of the fluid-bed has been developed by McNally Pittsburg for drying subbituminous coal. The design was based on pilot plant testing and computer simulation models combined with extensive experience in drying bituminous coals. The drying of a "Western coal" requires that most of the inherent moisture be removed. This process has been demonstrated in a 6 ton/hour pilot plant located at Danville. Test results have shown a successful removal of upwards of 75% of the initial moisture content. The pilot plant is a scaled-down model of a conventional commercial size McNally flowdryer with special additions, such as a cooler, to dry and cool low-rank coals. The removal of the inherent moisture differs from the removal of surface moisture in bituminous coals and thus requires special attention. Changes from conventional dryers included: (1) suppression of combustion during drying; (2) control and maintenance of a deep dryer bed; (3) rapid cooling of the dried product to approach the ambient temperature; and (4) treatment of the dried, cooled product to suppress oxidation and spontaneous combustion and to suppress dust loss. 4 refs., 15 figs.

31362 **(DOE/PC/60806—T5) Preparation of super-clean coal. Effect of media size in stirred ball mill grinding. Technical progress report for the ninth and tenth quarters, September 15, 1985-March 14, 1986.** Yoon, R.H.; Adel, G.T.; Mankosa, M.J. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Mining and Minerals Engineering). May 1986. Contract FG22-83PC60806. 28p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010433.

As a prerequisite to producing super-clean coal with any physical coal cleaning process, such as microbubble flotation, the feed coal must be micronized to liberate finely disseminated mineral matter. The stirred ball mill is regarded as one of the most efficient devices for micronizing coal. Using a five-inch batch mill, the optimum operating conditions have been determined in terms of media size, the optimum operating conditions have been determined in terms of media size and media type. The rates of breakage determined with monosized feeds are compared on the basis of specific energy consumption. It has been found that a 20:1 ball size/particle size ratio gives optimum grinding conditions. 10 refs., 10 figs.

31363 **(DOE/PC/70003—T9) Coal pretreatment for two stage liquefaction. Quarterly report, January 1-March 31, 1986.** Derbyshire, F.J.; Luckie, P.T. (Pennsylvania State Univ., University Park (USA). Coll. of Earth and Mineral Sciences). 1986. Contract FG22-84PC70003. 19p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010322.

Work has continued on the characterization of size-density fractions from Wyodak coal. A sample of 1.4 f material has been selected as a liquefaction feedstock. A second sample has been used as a feed for liquid-liquid separation using heptane-water. Preliminary results from these experiments show some enrichment of vitrinite and rejection of ash and semifusinite. In the liquefaction research, the autoclave system is now fully operational and experiments are being conducted to investigate temperature-staged catalytic liquefaction using this reactor. Further tubing bomb experiments have been performed to investigate the influence of reaction variables on temperature staged liquefaction. It has been found that, when naphthalene is used as the solvent, there is negligible conversion to tetralin, either in the low-temperature stage or in the combined two-stage reaction. The result suggests that the catalytic mechanism may involve some direct interaction with the coal. A series of experiments has now been completed to examine the influence of process solvents on temperature-staged liquefaction. These solvents were recycle solvent fractions from the Lummus ITSL process when Wyodak coal; 650-850°F, 850+°F fractions and a 1:1 blend of these materials. In terms of performance, the distillate fraction was poor, the bend better and the 850+°F fraction most effective in promoting high oil yields and coal conversions. 6 refs., 4 tabs.

31364 **(DOE/PC/70765—8) Program of basic research on the preparation and stability of coal/water slurries. Quarterly report.** Casassa, E.Z.; Povirk, C.; Toor, E.W. (Carnegie-Mellon Univ., Pittsburgh, PA (USA). Dept. of Chemical Engineering). 31 Mar 1986. Contract FG22-84PC70765. 106p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86010574.

For the Black Creek coal, aged samples are also more easily wetted than the freshly ground ones, though the change is not so extensive as for the Upper Freeport coal. Black Creek coal also appears to undergo surface oxidation of carbonaceous portions of the surface over time, independent of the grinding or aging atmosphere, as was the case to a much greater extent for the heavily oxidized Lower Kittanning sample. Slurries of freshly ground Black Creek coal have relatively high ionic strength due to the dissolution of soluble inorganic material from the coal surface, but aged samples yield a lower concentration of dissolved ions. The reason for this change is unknown. For the freshly ground samples, sedimentation rate and settled volume indicate extensive flocculation of the suspended coal as a result of the high ionic strength. The aged samples show much less sign of flocculation. The Pittsburgh Seam No. 8 ROM coal is the highest ash coal examined in this study. Its silicon and aluminum content are similar to that of Upper Freeport, but the Pittsburgh Seam No. 8 coal is also very high in iron. The cleaned coal contains about one-quarter as much aluminum, silicon, titanium and potassium as the ROM coal, and about one-tenth as much iron, calcium, magnesium, sodium and sulfur. The carbonaceous surface shows no sign of oxidation for either the ROM or cleaned coal. Electrophoretic mobility and viscosity data for freshly ground samples of the ROM and cleaned coals indicate the ROM coal appears to be much more extensively aggregated than the cleaned coal. The characterization of both the Pittsburgh Seam No. 8 samples is not yet complete, but the evidence to date suggests that the ROM sample is similar to the Upper Freeport coal, while the cleaned coal provides an example of the effects of beneficiation on a very high ash coal. 45 figs., 41 tabs.

31365 **(EPRI-CS—4433) Coal Cleaning Test Facility campaign report No. 3: Stockton-Lewiston seam coal.** Moorhead, R.G.; Parkinson, J.W.; Torak, E.R.; Cavalet, J.R. (Kaiser (Raymond) Engineers, Inc., Homer City, PA (USA); Science Applications International Corp., Homer City, PA (USA)). Apr 1986. 257p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920269.

Campaign Report 3, issued by the Electric Power Research Institute's Coal Cleaning Test Facility, presents the results of two separate, but related, studies. The first chapter describes a test program (a Coal Cleanability Characterization) on Stockton-Lewiston Seam coal from Kanawha County, West Virginia: a coal whose quality can vary widely. Test results demonstrate improvements in energy recovery (in one test exceeding 90%) from supplementing cleaned coarse coal with cleaned intermediate (3/8-in. x 28M) and fine (28M x 0) coal. This improvement reduces boiler ash loading by a factor of 3-1/2 and reduces sulfur dioxide emission potential by 16%. The clean coal has a low slagging and fouling potential, making it a desirable fuel for dry-bottom, pulverized-coal utility boilers. Chapter 1 also describes tests of a belt filter press used to dewater the coal's fine refuse so as to reduce refuse disposal problems. Chapter 2 of the Campaign Report discusses the CCTF's coal sampling practices and experience. It explains theoretical sources of mechanical-sampler extraction bias, then turns to specific CCTF experience in eliminating unacceptable bias from mechanical bulk and gravity flow slurry samplers. The chapter describes the method used for determining bias and analyzing test data, and the modifications made to CCTF samplers during the course of formal test programs. The CCTF designates these peripheral achievements as "Concurrent Innovations." 5 refs., 39 figs., 28 tabs.

31366 **(EPRI-CS—4547) Coal Cleaning Test Facility: 1986 plan.** Bencho, J.R.; Hoffman, N.; McCollough, D.E.; Moorhead, R.G.; Parkinson, J.W.; Torak, E.R.; Akers, D.J.; Cavalet, J.R. (Kaiser (Raymond) Engineers, Inc., Homer City, PA (USA); Science Applications International Corp., Homer City, PA (USA)). May 1986. 225p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920274.

One of the major projects of the Electric Power Research Institute is the Coal Cleaning Test Facility (CCTF), a 25-ton per hour, commercial-scale, research and development facility established to advance coal-cleaning technology and investigate its potential for reducing the cost of generating electricity. The CCTF is a proving ground for coal-cleaning and dewatering strategies and for developing and demonstrating new coal-cleaning equipment and processes. The CCTF 1986 Plan defines CCTF objectives, gives highlights of past accomplishments, and describes in detail its planned 1986 activities, including scheduled Coal Cleanability Characterizations and Development and Demonstration projects (the CCTF's major activities) as well as separately-funded projects and facility upgrades planned for 1986. The CCTF 1986 Plan also describes the method of characterizing the cleanability of a coal and its approach to Development and Demonstration (D and D) projects (designed to improve understanding of proven coal-cleaning technologies and to accelerate the development and use of emerging technologies). The final section of the CCTF 1986 Plan presents the formal and informal means by which the CCTF communicates its findings to the electric utility industry and others. Various appendices provide more detailed information about test methods, D and D project selection methodology, analytical laboratory requirements, and CCTF flowsheet configurations. 26 refs., 41 figs., 46 tabs.

0140 Combustion

REFER ALSO TO CITATION(S) 31337, 31776, 31965, 32112

31367 **(DOE/PC/80261—2Q) Slagging retrofit pulsed coal combustor. Quarterly progress report, January-March 1986.** (Avco-Everett Research Lab., Everett, MA (USA)). 1986. Contract AC22-85PC80261. 24p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010637.

The months of January through March were devoted primarily to characterizing solids dispersion in the cold flow device and achieving ignition in the reactor. A series of experiments were performed in which pulverized coal and air were injected into the cold flow device. The relative time delay between the two was varied. Examination of the high speed films taken during these experiments revealed that in all cases discernible swirled bands of coal particles interspersed with void areas were formed. The timing variations have noticeable effects on the physical definition of these bands, the flow uniformity, and the combustion chamber clearing time. Another series of experiments revealed that the absence of a solids dispersion target results in unacceptably large percentages of the injected coal passing directly through the combustion volume in a slug. The amount of coal passed without mixing with the combustor gas varies with the timing delay. The maximum amount passed was approximately 80%. Our final major effort for the period was to construct a structurally stronger plexiglass unit in which actual combustion can occur and be viewed. We have had initial success with methane added to the coal/air mixture. Refinements have been made to the zero and one dimensional models. Individual species and swirling air motion are now accounted for. Work has begun on the development of a two dimensional code. 11 figs.

31368 **(DOE/PC/80528—T2) Group combustion of coal particles. Quarterly progress report No. 2, December 15, 1985-March 15, 1986.** Annamalai, K. (Texas A and M Univ., College Station (USA). Dept. of Mechanical Engineering). 10 Apr 1986. Contract FG22-85PC80528. 47p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86009769.

Sprays play a major role in both the design and performance of combustors. Spray combustion models are based on the premise that individual drop combustion occurs. However recent experiments on spray combustion reveal that a sheath flame exists around the boundary of the spray cone in the vicinity of the spray injector while individual drop combustion occurs farther downstream. Thus there exists a common flame around a group of droplets (group combustion) rather than a flame around each droplet (drop combustion). The group combustion model of a cloud of droplets/particles yields a very low burning rate compared to the burning rate predicted with the single drop/particle combustion model; further the group combustion leads to increased volume of the fuel rich zone which promotes soot formation; on the other hand, fuel rich conditions may reduce NO/sub x/ formation. The ignition temperature under the group ignition model is expected to yield a lower value than the ignition temperature predicted with the single drop/particle ignition model. Thus the ignition temperature, combustion rate and the pollutants emission depend upon whether group combustion or individual drop combustion occurs. The spray conditions in gas turbines/swirl burners are conducive to the occurrence of group ignition and combustion. Hence group ignition and group combustion models are appropriate for modeling the sprays as well as to interpret the experimental data on combustion behavior in furnaces. Further, while most of the earlier experiments were performed with a cloud/stream particles, the interpretations regarding the kinetics of pyrolysis, char oxidation and the product of heterogeneous oxidations were based mainly on the individual particle combustion model. These experimental data will be reexamined and reinterpreted with models based on group combustion. 27 refs., 8 figs., 2 tabs.

31369 **Coal Combustion and Utilization: a current awareness bulletin.** Chertok, D.M. (ed.). (Dept. of Energy, Technical Information Center, Oak Ridge, TN). *Coal Combustion and Utilization;* **86**: No. No. 1, 5(15 Jan 1986). (PB—86-914400; DOE/CCU—86/1).

Available from National Technical Information Service, Springfield, VA 22161 on a subscription basis at $45.00 per volume (calendar) year.

Recent information on the following subjects is included within the scope of this publication, but all subjects may not appear in each issue: coal combustion, power plant fuel, MHD generators, fuel cells, combustion chemistry, and combustion systems. Information on coal, including combustion, MHD generators, and fuel cells, is also available for on-line searching and retrieval in the Energy Data Base using the DOE/RECON system or commercial on-line retrieval systems. Coal Combustion and Utilization (CCU) is available to DOE and DOE contractor personnel through the Technical Information Division, Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831. Others may obtain CCU from the National Technical Information Service, Springfield, VA 22161 as PB86-914400. The annual subscription price is $45.00 (domestic) and $90.00 (outside the North American continent).

31370 **Overview of DOE's advanced/MHD coal combustor development programs.** Carabetta, R.A.; McCann, C.R.; Kurtzrock, R.C. (Dept. of Energy, Pittsburgh, PA). *Energy Technology (Washington, D.C.);* **12**: 1311-1323(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

An overview of DOE research on combustion devices covers work under the Coal-Fired Magnetohydrodynamic (MHD) Power Systems Program and Advanced Combustion Systems Program. The work covers a broad range of technology at various stages of development. The MHD combustor effort will develop a durable, low heat-loss device capable of operating at pressure of up to eight atmospheres, producing combustion gases at temperatures approaching 5000 deg. F, and rejecting, as slag, at least 70% of the mineral matter contained in the coal. The scope of the Advanced Coal Combustion Systems Program is to develop and evaluate low-cost, environmentally acceptable technologies for a broad range of users. The program includes industrial participation and cost sharing. Among the efforts in progress, the TRW 50 MWt MHD combustor and its related 50 MMBtu/hr commercial/industrial variant appear to be the most highly developed at this time. 6 references, 5 figures, 1 table.

31371 **Low-NOx staged gas turbine combustor concept for coal-water slurry application.** Wilkes, C.; Clark, D.W. (Allison Gas Turbine Division, Indianapolis, IN). *Energy Technology (Washington, D.C.);* **12**: 1336-1345(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Work conducted at the Morgantown Energy Technology Center under DOE contract investigated the combustion characteristics of a low nitrogen oxide (NO/sub x/) combustion system burning a coal-water slurry (CWS). The slurry was produced from a clean micronized coal, mixed with water, and maintained in suspension with an average coal/water loading of 51.5/48.5%. The combustion system was the rich-quick quench-lean (RQL) type used in previous programs to reduce NO/sub x/ emissions resulting primarily from fuel bound nitrogen. The authors describe results obtained using distillate #2, methanol, methanol/CWS mixtures, and those from CWS alone. Combustion efficiencies with CWS were in the mid 90% range with NO/sub x/ emissions as low as 92 ppmv at 15% oxygen. The results indicate that further testing and modifications are needed to increase efficiency to the level of that obtained with a petroleum distillate fuel.

31372 **CaO interactions in the staged combustion of coal.** Levy, A.; Merryman, E.L.; Rising, B.W. New York, NY; American Institute of Chemical Engineers (1985). 65p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC22-80PC30301.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

The interaction of CaO with pyrite, COS, H_2S, and SO_2 were examined under fuel-rich conditions to determine the role of CaS formation in the LIMB process. Rate calculations based on differential reactor kinetics suggest that CaS formation in the second or less available is low. Coal-burning experiments on the fuel-rich side using CaO-impregnated coals also show that CaS formation is minimal. The experimental studies suggest that sulfide-sulfate-sulfur dioxide equilibria deter the formation of CaS in the fuel-rich zones of LIMB, necessitating that CaO be added with the secondary or tertiary air for optimum removal of sulfur dioxide.

31373 **Combustion of calcium treated coals.** Chang, K.; Flagan, R.C.; Gavalas, G.P. New York, NY; American Institute of Chemical Engineers (1985). 30p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract FG22-83PC60801.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

The combustion of calcium-exchanged coals was studied in laminar flow and fluid bed reactors uder strongly fuel-lean conditions. The purpose of the study was to understand the nature of release and capture of sulfur oxides in the presence of finely dispersed calcium oxide and explore the effectiveness of calcium-exchange pretreatment for sulfur emission control in coal combustion. The experimental variables were residence time, oxygen concentration, furnace temperature and amount of calcium-additive. The two coals used in this study were PSOC 623, a Texas lignite, and PSOC 680, an Indiana high volatile B bituminous. Analysis of the experimental data indicated that sulfur capture increased as residence time or oxygen concentration increased. The results also showed that sulfur capture was approximately proportional to the Ca/S ratio of the coals.

0150 Marketing And Economics

REFER ALSO TO CITATION(S) 32018

31374 **(ANL/CNSV—52) Estimates of the value of carbon dioxide from the Great Plains Coal Gasification Plant.** Wolsky, A.M.; Nelson, S.H.; Jankowski, D.J. (Argonne National Lab., IL (USA)). 28 Jul 1985. Contract W-31-109-ENG-38. 73p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010419.

This report develops a framework and methodology for estimating the value of carbon dioxide produced by the Great Plains Coal Gasification Plant. The petroleum industry could use this CO_2 as a solvent for enhanced oil recovery. The value of CO_2 is found to be a function of the geological characteristics of the petroleum reservoirs being flooded, the cost of transporting the CO_2, and the presence or absence of competitors selling CO_2. Carbon dioxide demand curves for oil fields in Montana and North Dakota are developed for various economic conditions, and sensitivity analyses are performed. 22 refs., 4 figs., 21 tabs.

31375 (DOE/METC—86/6036-Vol.2, pp 616-628) **ENDESA in the Spanish coal industry: Puentes Lignite Mine.** Calvo, J. (ENDESA, Madrid, Spain). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

ENDESA's role in the Spanish coal industry is presented. This was 45.2% of the market in 1984. As an important part of this role, Puentes Lignite Mine is described: the deposit; mine lay-out; start-up problems both at the power plant and the mine; decisions taken; performance; as well as the present situation at the mine.

0160 Health And Safety

31376 **(EPRI-EA—4490) Techniques and models to estimate the health benefits of controlling toxic substances emitted from coal-fired power plants. Final report.** Freeman, T.; Eger, T.; Harding-Barlow, I.; Lautzenheiser, J.; Brown, S. (SRI International, Menlo Park, CA (USA)). Mar 1986. 151p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920255.

Discharge of toxic substances from coal-fired power plants may be regulated under various sections of the Clean Water Act. The appropriate level of control depends on the costs of the controls and the resultant reductions in risks to human health. This study reviews currently available techniques and models for use in assessing the risks, costs, and benefits of controlling toxic substances emitted by coal-fired power plants. The results of analyses based on these techniques and models may be used to inform regulatory decisions under the Clean Water Act and other environmental laws regarding appropriate pollutant control strategies for specific electric power plants or power plants in general. The techniques and models presented cover the sources of pollutant emissions at the power plant and the costs and effectiveness of alternative pollutant controls; atmospheric and surface and groundwater transport of the pollutant; plant and animal uptake of the pollutant and subsequent bioconcentration, biotransformation, and bioaccumulation; human exposure to the pollutant via inhalation, ingestion, and dermal exposure and the resulting health risks; and balancing the benefits of reductions in risks to human health against the costs of controlling the pollutant.

31377 **(PB—86-156205/XAB) Reducing hazards in underground coal mines through the recognition and delineation of coalbed discontinuities caused by ancient channel processes. Report of Investigations/1985.** Kertis, C.A. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1985. 33p. (BM-RI—8987). NTIS, PC A03/MF A01.

Because coalbed discontinuities often pose serious economic and safety problems in underground coal mines, criteria were documented for the recognition and prediction of discontinuities in advance of mining. Pennsylvanian strata in Indiana and Armstrong Counties, PA, were deposited as part of fluvio-deltaic complexes with channel-phase sandstones as the predominant type of coalbed discontinuity. By using the criteria developed in the study and described in the Bureau of Mines report, the occurrence of coalbed discontinuities may be predicted and anticipated in advance of mining.

31378 **(PB—86-156213/XAB) Exhaust ventilation of deep cuts using a continuous-mining machine. Report of Investigations/1985.** Volkwein, J.C.; Ruggieri, S.K.; McGlothlin, C.; Kissell, F.N. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1985. 23p. (BM-RI—8992). NTIS, PC A02/MF A01.

The Bureau of Mines, Foster-Miller, Inc., and Beaver Creek Coal Co. have evaluated the ability of a new system to ventilate a 40-ft-deep cut. A remote-control continuous-mining machine, in a 7-ft-thick seam, with exhausting brattice was fitted with an improved sprayfan system plus additional forward and reverse pointing sprays. Static and dynamic tests using tracer gas were conducted in a full-scale model and underground to measure the effectiveness of exhaust face ventilation for various deep-cutting mine and spray configurations. When compared to a 10-ft primary ventilation brattice, the extended-cut spray system consistently provided better face ventilation at all configurations up to and including a 40-ft brattice setback. The system also provided good dust protection and visibility for the machine operator. Another safety advantage is the elimination of the need to set temporary roof supports to maintain the ventilation brattice.

31379 **(PB—86-156403/XAB) Electrical-ignition energies and thermal autoignition temperatures for evaluating explosion hazards of dusts. Report of Investigations/1985.** Hertzberg, M.; Conti, R.S.; Cashdollar, K.L. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1985. 48p. (BM-RI—8988). NTIS, PC A03/MF A01.

The Bureau of Mines measured the energy requirements for the spark ignition in air of Pittsburgh seam bituminous coal dust, lycopodium spores, and polyethylene powder with a 1.2-L furnace and 8-L and 20-L chambers. Thermal autoignition temperatures of the same dusts were measured in the 1.2-L furnace. Electrical-ignition requirements are given in terms of both effective spark-gap energies, and stored circuit energies, 1/2 CE2. The measured order of electrical ignitability for the three dusts is consistent with the data of other researchers; however, the absolute values are systematically higher, probably because of higher flow and turbulence levels in the chambers used and lower electrical efficiency in the circuit used here. However, some valuable information may be obtained from the relative ignition energies of various dusts at ambient and elevated temperatures. In addition, the concept of minimum electrical ignition energies for homogeneous gas mixtures is reevaluated theoretically.

31380 **(PB—86-156445/XAB) Determining face methane-liberation patterns during longwall mining. Information circular/1985.** Cecala, A.B.; Jankowski, R.A.; Kissell, F.N. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1985. 16p. (BM-IC—9052). NTIS, PC A02/MF A01.

As deeper seams are continually mined, methane liberation will continue to increase and must be monitored effectively. To effectively monitor and develop appropriate control technology, methane-liberation patterns must be known. The Bureau of Mines recently completed a study to identify specific patterns of face methane liberation during longwall mining. Both of the longwall faces surveyed had high methane liberation rates. At one longwall face, most of the methane was liberated during cutting of coal by the shearer mining machine. At the second face, a significant portion of methane was emitted from the face and floor. An effective methane-monitoring system would be different for each longwall panel because of the differences in how the gas is released along the face.

31381 **(PB—86-156981/XAB) Methane control on longwalls with cross-measure boreholes (Lower Kittanning Coalbed). Report of investigations/1985.** Garcia, F.; Cervik, J. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1985. 24p. (BM-RI—8985). NTIS, PC A02/MF A01.

The cross-measure borehole technique has been shown by the Bureau of Mines to be an effective method of controlling methane liberated by fracturing the roof strata in longwall gobs where overburden is less than 750 ft (229 m). Boreholes are drilled into roof strata before mining operations affect the roof strata. Longwall mining fractures the roof strata and releases methane from source beds. Surface exhausters or vacuum pumps are used to draw the gas to the surface through an underground pipeline and vertical exhaust hole. The captured methane is thus prevented from entering the mine's ventilation system. About 71% of the methane produced by longwall mining in the Lower Kittanning Coalbed was captured by the cross-measure boreholes. Borehole spacing is an important factor affecting the performance of the technique.

31382 **(PB—86-160801/XAB) Coal mine injury and employment experience by occupation, 1976-1980. Informational report.** Larson, L.P. (Mine Safety and Health Administration, Denver, CO (USA). Safety and Health Technology Center). 1985. 67p. (MSHA/IR—1175). NTIS, PC A04/MF A01.

The report presents the injury and employment experience, from 1976 through 1980, of selected occupations in the coal-mining industry. Injury data from the MSHA Health and Safety Analysis Center's data base are matched with employment data for individual occupations collected through respirable dust-sampling procedures, providing fatality and injury rates for each occupation. The rates are used to establish a ranking of occupations according to their level of risk.

31383 **(PB—86-161577/XAB) Injury experience in coal mining, 1983. Informational report.** (Mine Safety and Health Administration, Denver, CO (USA). Safety and Health Technology Center). 1985. 386p. (MSHA/IR—1170). NTIS, PC A17/MF A01.

The Mine Safety and Health Administration (MSHA) informational report reviews in detail the occupational injury and illness experience of coal mining in the United States for 1983. Data reported by operators of mining establishments concerning work injuries are summarized by work location, accident classification, part of body injured, nature of injury, occupation, and anthracite or bituminous coal. Related information on employment, worktime, and operating activity also is presented. Data reported by independent contractors performing certain work at mining locations are depicted separately in the report. For ease of comparison between coal mining and the metal and nonmetal mineral mining industries, summary reference tabulations are included at the end of both the operator and the contractor sections of the report.

31384 **Developmental toxicity following oral administration of a high-boiling coal liquid to pregnant rats.** Hackett, P.L.; Rommereim, D.N.; Sikov, M.R. (Pacific Northwest Lab., Richland, WA). *JAT, Journal of Applied Toxicology;* **4**: No. 1, 57-62(1984). Contract AC06-76RL01830.

Heavy distillate (HD), the highest-boiling coal liquid from the solvent-refined coal-II process (SRC-II), was administered by intragastric (IG) intubation to pregnant rats. Five dose levels of HD (0.09, 0.14, 0.18, 0.36 and 0.74 g kg^{-1}), were given daily from 12 to 16 days of gestation and the rats were killed at 20 days of gestation. Maternal body weights and weights of the liver, kidneys, spleen, adrenals, thymus, ovaries and the gravid uterus were obtained. Gravid uteri were evaluated for prenatal mortality. Live fetuses were examined for malformations and weighed; fetal lungs were excised and weighed. Maternal (extragestational) weight gains and thymic weights diminished in all groups that received the SRC material. Adrenal weights were increased in all treated animals, except for those in the lowest-dose group (0.9 g kg^{-1}). There was significant maternal mortality at 0.74 g kg^{-1} and increased intrauterine mortality at doses of 0.37 and 0.74 g kg^{-1}. Placental weight was depressed, and the incidence of fetal anomalies was increased at 0.14 g kg^{-1} and all higher dose levels. 19 references, 1 figure, 5 tables.

0170 Legislation And Regulations

REFER ALSO TO CITATION(S) 31778

02 PETROLEUM

0202 Geology And Exploration

REFER ALSO TO CITATION(S) 31419

31385 Meteoric burial diagenesis of Pennsylvanian arkosic sandstones, southwestern Anadarko Basin, Texas. Dutton, S.P.; Land, L.S. (Univ. of Texas, Austin). *American Association of Petroleum Geologists, Bulletin;* 69: No. 12, 22-38(Dec 1985). Contract AC97-83WM46651.

Pennsylvanian arkosic sandstones at Mobeetie field were deposited in fan deltas that prograded onto a shallow shelf in the southern Anadarko basin. The detrital minerals of the sandstones reflect the composition of the Precambrian granites and granodiorites that were exposed in the nearby Amarillo uplift. Distal margins of some fandalta lobes were reworked by marine processes, and carbonate fossil fragments and oolites were mixed with terrigenous clastics. The diagenetic history and, hence, reservoir quality of the distal, marine-reworked sandstones differ from those of the more proximal, nonreworked sandstones. These diagenetic events are discussed. 13 figures, 1 table.

31386 Log analysis techniques for quantifying the permeability of sub-millidarcy sandstone reservoirs. Kukal, G.C.; Simons, K.E. (CER Corp.). pp 303-310 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—).

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

Techniques to quantitatively determine formation matrix permeability from log data were investigated to establish relationships valid for the DOE Multi-Well Experiment (MWX) Mesaverde Section. Exponents and constants for the equation were derived by comparing MWX log data to stressed core permeability measurements. The calculation simulates in situ absolute matrix permeability at initial net stress conditions. The calculated permeability is accumulated foot-by-foot to yield the absolute permeability of the zone (k x h). Another approach to permeability quantification relates matrix permeability to the relative degree of mud filtrate invasion. When adequate time and differential pressure exist, filtrate invasion is expected to occur, although only to the extent that formation permeability allows. The degree of invasion is quantified by comparing the saturation of the deep zone to that of the near zone, giving the difference, ΔS/sub W/. Deep zone saturations are determined by using deep resistivity logs and iteratively analyzed porosity while the near zone saturation is modeled from the density, neutron and gamma ray log responses. Formations having higher permeability have correspondingly greater invasion and higher ΔS/sub W/. ΔS/sub W/ is accumulated to yield the foot-by-foot product ΔS/sub W/ x h for each zone. Correlations of the two methods to each other and to in situ simulated core matrix permeability are good to excellent at MWX. Equally good results were obtained using East Texas Travis Peak (Hosston) data.

31387 In-situ stress determination from wellbore elongation measurements. Blanton, T.L.; Teufel, L.W. (Science Applications International Corp.). pp 279-292 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—).

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

This paper explores the feasibility of making in situ stress measurements at depth from caliper measurements of deformed wellbores. The work has been carried out in three steps: (1) theoretical development of viscoelastic constitutive equations necessary for calculation of stress directions and magnitudes, (2) application of the equations to field data, and (3) comparison of results to stress measurements made by hydraulic fracturing and overcoring methods. The results of the theoretical analysis are equations that relate the minimum and maximum radii of a deformed wellbore to the maximum and minimum stresses perpendicular to the axis of the wellbore. Calculation of absolute magnitudes of stresses requires the viscoelastic compliance and Poisson's ratio of the rock, but even when this information is not available relative magnitudes of stresses can be determined. The constitutive equations were applied to caliper measurements of a horizontal borehole in unwelded ashfall tuff near an underground tunnel complex in Rainer Mesa on the Nevada Test Site. The horizontal borehole was aligned in the direction of the maximum horizontal stress. Over a 37 day period the wellbore showed time-dependent deformation, with maximum closure in the maximum stress direction (overburden). The ratio of principal stress calculated from caliper measurements of the deformed wellbore varied from 1.73 to 2.06, depending on the time interval used. The ratios obtained from overcoring and hydraulic fracturing were 1.79 +- .22 and 2.12 +- .12. Limitations of this approach to stress measurement are discussed, but results of the present study suggest that with further development of the viscoelastic constitutive model, stress variations along the length of the wellbore might be readily examined as part of the well logging process.

0203 Drilling And Production

REFER ALSO TO CITATION(S) 31374, 31387, 32359

31388 (DOE/MC/21136—7) Improvement of CO_2 flood performance. Quarterly report, October 1-December 31, 1985. Heller, J.P.; Kovarik, F.S. (New Mexico Inst. of Mining and Technology, Socorro (USA). New Mexico Petroleum Recovery Research Center). Feb 1986. Contract FC21-84MC21136. 56p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010754.

In Area I, the newly rebuilt Continuous Multiple Contact (CMC) apparatus was put through a shakedown operation to test the temperature control, viscometers, and new process control software. Further development of the oscillating crystal viscometers has involved investigation of the anomalous viscosity measurements of compressed methane that were discussed in the project review, and the construction of crystal-holders to use 10:1 (length to diameter ratio) crystals. Simultaneous measurements of the composition, viscosity, and density of phases in equilibrium, for both synthetic and crude oil-CO_2 systems, is under way. In Area II, we discuss the observed relationship between the scale of heterogeneity in a core and heterogeneous displacement characteristics during a miscible flood. We present results from simulations which tie the heterogeneity observed in thin sections to residential oil saturation after a CO_2 displacement. We also include a written version of some of that material on mixing and dispersion in sand and glass bead packs, which was presented for the first time at the project review. This subject is introduced as a new area of investigation, as part of a study which aims to set standard specifications for the geometry and procedures of slim-tube tests. Area III, concerning the development and use of mobility control materials and procedures for CO_2 floods, is also represented in this report. Some additional laboratory work has been performed on the new method of mobility measurement of CO_2-foam that was previously reported and is discussed briefly. A more extensive section of the report is devoted to the latest results of syntheses and measurements of direct thickeners. A new experiment being prepared for measurement of the utility of mobility control additives is also discussed. 13 refs., 23 figs., 8 tabs.

31389 (DOE/SF/01424—T8) Multi-pattern low-tension demonstration flood big muddy field. Technical progress report, January-March 1986. Mosley, M.K. (Conoco, Inc., Casper, WY (USA)). Apr 1986. Contract AC03-78SF01424. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009767.

The Big Muddy Low-Tension Flood is a commercial size demonstration project consisting of nine 10-acre injection patterns in the heart of the Big Muddy oil field located about 15 miles east of Casper, Wyoming. Project objectives relate to surfactant flooding in the low permeability, high fracture density, fresh water reser-

voirs typical of many fields in eastern Colorado and Wyoming. During the past quarter, injection of water continued through the first quarter of 1986. Injection wells No. 84, 85, and 101 remained shut-in, and the remaining six injectors averaged about 200 BWPD per well. Although bottom-hole injection pressures were not measured, it is felt that pressure-parting still occurred. January, February and March sales averaged 98 BOPD, 103 BOPD and 92 BOPD, respectively. February sales included an extra 100 barrels of oil from an overflow and skim of the produced water tank. The cumulative project sales were 252,028 barrels of oil as of March 31, 1986. The project again was operated in the black as revenue exceeded total operating costs. 6 figs., 4 tabs.

31390 **(NIPER—76) Heavy oil recovery by CO_2 immiscible displacement method.** Chung, T.H. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). Apr 1986. Contract FC22-83FE60149. 70p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86000281.

Heavy oil recovery techniques are being developed at the National Institute for Petroleum and Energy Research (NIPER) in Bartlesville, Oklahoma. This report describes the results of studies made to investigate the mechanisms of immiscible CO_2 displacement for heavy oil recovery. Viscosity reduction, oil swelling, and hydrocarbon extraction are the major mechanisms being studied. Measurements of viscosity reduction, density change, swelling factor, and CO_2-solubility have been conducted for 7 heavy crudes with API gravity in the range of 10° to 22°. A correlation has been developed between the viscosity reduction and the quantity of CO_2 dissolved. The viscosity correlations developed in this work can be used to predict the viscosity of heavy oils and mixtures of CO_2 for process design and simulation of immiscible displacement process. The extraction of oil by high pressure CO_2 has also been studied. Laboratory tests were conducted to determine the quantity of oil extracted by CO_2 from a heavy crude (21.6° API gravity) at 2000 and 3000 psig, and at temperatures of 100° F and 150°F. Information from such laboratory results can be used in the design and implementation of more effective and economical immiscible CO_2 displacement for oil recovery projects. 27 refs., 22 figs., 14 tabs.

31391 **(NIPER—97) Selected mathematical methods for reservoir characterization: state-of-the-art review. Topical report, Project BE1, Task 2.** Tomutsa, L. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). Mar 1986. Contract FC22-83FE60149. 20p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010799.

Mathematical and statistical methods currently used in improved descriptions of oil reservoirs are surveyed. These methods are used as follows: (1) to discriminate between strata of different properties, (2) to group strata with similar properties, (3) to calculate effective values for simulator input parameters at a simulator grid bloc scale by using core data (scale-up), and (4) to interpolate between wells for predicting values to be used in the interwell grid blocs. For appropriate use of most of the methods described, more data are needed compared with what is usually available from cored wells. Procedures which include use of well logs and/or nearby outcrop data provide some extra data, based on quantitative understanding of the geological features characteristic to a reservoir. 27 refs., 1 fig.

31392 **(NIPER—118) Adaptation of the black oil simulator to two-phase and three-phase relative permeability determination using unsteady-state technique. Status report, Project BE1, Task 4.** Maerefat, N.L.; Parmeswar, R. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). May 1986. Contract FC22-83FE60149. 29p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010798.

The development of an unsteady-state procedure for determining three-phase relative permeability curves requires the characterization of the relative permeability curves by adjustable parameters and the adaption of a nonlinear least-squares procedure to the finite-difference approximation of the Buckley-Leverett three-phase flow equation including capillary pressure. A method was developed to represent three-phase relative permeability data by a functional form based on experimental data. Three-phase relative permeability experimental data reported by previous investigators were represented by relative permeability functions. These functions express the relative permeability of a given phase to all fluid saturations (three saturations in the case of three-phase flow) by a six parameter power law equation. The six parameter equations fit the experimental data within 0.53% error. An automatic method also was developed for representing three-phase relative permeability expeimental data. This procedure eliminates errors due to subjective bias. The developed relative permeability functions were incorporated in a multi-dimensional, three-phase black oil simulator. Also, a finite difference Levenberg-Marquardt routine for solving least-squares problems was adapted to the black oil simulator. These modifications make the estimation of the parameters in the relative premeability functions possible by fitting simulated transient three-phase displacement tests to experimental tests. Preliminary results using two-phase flow displacement showed that the parameters can be estimated within a reasonable amount of computer time. Although preliminary results showed that the program works adequately for two-phase flow, conclusions cannot be stated at the present time since some errors were found in the Fortran code of the optimization function. Appropriate changes have been made, and the new version is being tested.

31393 **(NIPER—145) Determining possible correlations between pseudo Dykstra-Parsons coefficient and deposystem types.** Sharma, B. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). Mar 1986. Contract FC22-83FE60149. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010800.

Results of a limited study of 26 Department of Energy (DOE) cost-shared enhanced oil recovery (EOR) projects indicate no definite relationship between the various deposystems and the calculated pseudo Dykstra-Parsons coefficients (V/sub PDP/) in these deposystems. The calculated V/sub PDP/ values for the various deposystems are not confined within narrow limits; sometimes even within a single field the Dykstra-Parsons coefficient of permeability variation (V/sub DP/) fluctuate over a wide range. In such fields the fluctuations in V/sub PDP/ values would also be correspondingly large. It is recommended that selection of a deposystem with high EOR potential for detailed study of reservoir heterogeneities and their effects be accomplished by the alternate method proposed in the FY86 Plan. This method is based on the occurrence of significant oil accumulations and EOR projects in the deposystem. 1 tab.

31394 **(PB—86-159837/XAB) Environmental assessment of an enhanced-oil-recovery steam generator equipped with a low-NOx burner. Volume 1. Technical results. Final report, January 1984-January 1985.** Castaldini, C.; Waterland, L.R.; Lips, H.I. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Feb 1986. 71p. (ACUREX/TR—84-161/EE). NTIS, PC A04/MF A01.

The report discusses results from sampling flue gas from an enhanced-oil-recovery steam generator (EOR steamer) equipped with an MHI PM low-NOx burner. The tests included burner performance/emission mapping tests, comparative testing of an identical steamer equipped with a conventional burner, and comprehensive testing of the low-NOx-burner-equipped steamer. Comprehensive test measurements included continuous flue-gas monitoring; source assessment sampling system testing with subsequent laboratory analysis to give total flue-gas organics in two boiling point ranges and specific quantitation on the semivolatile organic priority pollutants; C1 to C6 hydrocarbon sampling; Methods 5/8 sampling for particulate and SO_2 and SO_3 emissions; and emitted particle size distribution tests using Andersen impactors. Full-load NOx emissions of 110 ppm (3% O_2) could be maintained from the low-NOx burner at acceptable CO and smoke emissions, compared to about 300 ppm (3% O_2) from the conventional-burner-equipped steamer. At the low-NOx condition, CO, SO_2, and SO_3 emissions were 93, 594, and 3.1 ppm, respectively. Particulate emissions were 39 mg/dscm with a mean particle diameter of 3 to 4 micrometers. Total organic emissions were 11.1 mg/dscm, almost exclusively volatile (C1 to C6) organics. Three PAHs were detected at from 0.1 to 1.4 micrograms/dscm.

31395 (SAND—83-1421) NO/NO/sub x/ analyses in gaseous effluent containing high concentrations of CO_2 and CH_4 using the TECO model 10AR chemiluminescent NO/NO/sub x/ analyzer. Jensen, A.L. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1986. Contract AC04-76DP00789. 62p. (TTC—0439). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010627.

Org. 6324 was requested to evaluate the TECO model 10AR NO/NO/sub x/ Analyzer to determine what effects high concentrations of CO_2 and CH_4 have on its operation. The study reported here showed the TECO instrument was suitable for the studies in oil field environments and that the concentrations of CO_2 and CH_4 representing oil field and steam generator effluents cause no adverse effects on the detection of NO/NO/sub x/. 15 refs., 4 figs.

31396 Application of the theory of coherence to surfactant flooding. Saneie, S.; Yortsos, Y.C. New York, NY; American Institute of Chemical Engineers (1985). 19p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC03-81SF11571.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Previous studies have shown that in the absence of dispersion a surfactant flooding process is amenable to a simplified solution by the method of coherence. The development of solution requires the construction of composition paths obtained numerically by the integration of ordinary differential equations. In this note the authors show that in the particular case when all tie-lines in the triangular phase diagram originate from a single point on the W-O axis, the construction of the composition paths can be considerably facilitated.

31397 An experimental study of foam in porous media for steam injection improvement. Crastanier, L.M.; Brigham, W.E. New York, NY; American Institute of Chemical Engineers (1985). 23p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC03-76ET12056;AC03-81SF11564.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

A research program on steam injection with additives to improve sweep efficiency has been undertaken for several years by the Stanford University Petroleum Research Institute (SUPRI). The laboratory effort has been aimed towards the study of thermal stability of foaming agents and of the flow behavior of foams in porous media. A screening process has been developed for selecting suitable surfactants for use as foaming agents during a steam drive. Three sequential experiments, one at 212°F (100°C) for a week, the second at 400°F (205°C) for a few hours, and the last one at 400°F (205°C) for several weeks, allow the selection of chemicals stable at high temperature in the presence of oil and porous media. In parallel, the flow of foams in porous media has been studied in micromodels, in physical models representing a cross-section of a reservoir and in one-dimensional tubes. In this last case, injection of steam with surfactant yielded pressure gradients much higher than the control runs, using steam only, thus showing blocking action of the foam.

31398 Thermodynamics of microemulsions and other near-critical mixtures: An ultracentrifugation study. Rossen, W.R.; Davis, H.T.; Scriven, L.E. New York, NY; American Institute of Chemical Engineers (1985). 39p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Microemulsions employed in enhanced-oil-recovery processes behave in many ways as near-critical mixtures. The similarities suggest that in microemulsions as in mixtures near critical points the component chemical potentials change little with composition in a certain direction in the phase diagram. This is confirmed here for microemulsions for the first time by direct measurement of the chemical potentials of all components in solution. In the microemulsion system tested, the chemical potentials are nearly constant along a path extending from nearly pure oil to midrange to nearly pure water. The persistence of this near-critical behavior over so wide a range of compositions is associated with the peculiar microemulsion properties that are crucial to enhanced oil recovery. In two systems of oil and water with protosurfactant alcohols, the change in chemical potentials with composition, except near critical solution points, is found to be much greater than in a true microemulsion of oil and water with a nonionic surfactant. The experimental technique employed is equilibrium ultracentrifugation, in which concentration gradients in the centrifugal field reveal the mixture equation of state. Strengths and weaknesses of the technique are delineated. Equilibration times are long, but a single equilibrium experiment can give a wealth of data.

31399 A model of the hydraulic fracturing process for elongated vertical fractures and comparisons of results with other models. Palmer, I.D.; Luiskutty, C.T. (Oral Roberts Univ.). pp 145-162 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—).

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

A summary is given of a fracture model that calculates fracture height as a function of distance from the wellbore for the case of a continuous payzone bounded by zones in which the minimum in situ stress is higher. The model is applicable if the vertical fracture is highly elongated, with length/height ratio $\geqq 3.5$. The fluid flow therefore is essentially one-dimensional along the fracture length. The flow can be non-Newtonian. Leak-off is included, as well as spurt loss, but pumping rates and injected fluid properties are constant with time. Elastic properties do not vary from one zone to another. The model calculates width profiles in each vertical section of the fracture. Finally, both fracture height and bottomhole pressure are calculated as a function of time. A comparison is made betwen the results of this model (ORU model) and the AMOCO, MIT, and TERRA-TEK variable-height models. There are areas of agreement and disagreement. A critical assessment is made of assumptions that differ in the models in an effort to reconcile the models. The conclusion is that the ORU, AMOCO, and TERRA-TEK models are in basic agreement for highly elongated fractures.

31400 A comprehensive fracture diagnostics experiment: Part II - comparison of seven fracture azimuth measurements. Smith, M.B.; Ren, N.K.; Sorrells, G.G.; Teufel, L.W. (Amoco Production Co.). pp 443-458 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—).

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

A great deal of effort has been devoted recently to find geophysical techniques for measuring the hydraulic fracture azimuth. This paper discusses a comparison of seven different measurements used to determine the azimuth in a sandstone formation at a depth of 1,000 ft (320 m). The azimuth was determined as N95E, but significant differences existed between some of the results. This is of fundamental importance since in developing new measurements, the limits of these must be found and honored. Of particular interest are the results from microseismic monitoring. The lack of results suggests that remote (e.g., surface) monitoring for seismic events may be impractical for normal, sedimentary, hydrocarbon-bearing formations.

31401 In-situ stress state in the mounds test well as determined by the anelastic strain recovery method. Teufel, L.W. (Sandia National Labs.). pp 467-474 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—). Contract AC04-76DP00789.

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

A method to determine in-situ stress directions and magnitudes from anelastic strain recovery measurements of oriented core has been used to determine the principal horizontal in-situ stresses in the mounds test well near Tulsa, Oklahoma. The mounds experiment was a shallow field experiment designed to evaluate and com-

pare various methods of determining hydraulic fracture azimuth and geometry at depth. The azimuth and geometry of hydraulic fractures are controlled primarily by the orientation and magnitudes of the principal in-situ stresses. In the mounds experiment the principal horizontal stress directions were determined directly from the principal horizontal strain recovery direction of oriented core. The principal horizontal stress magnitudes were calculated from the principal strain recovery magnitudes, effective overburden stress, and mechanical properties of the rock using a viscoelastic model. The in-situ stress directions and hydraulic fracture azimuth determined from anelastic strain recovery measurements were within 10° of the fracture azimuth determined from a downhole television camera and a surface tiltmeter survey of a propagating hydraulic fracture. The minimum horizontal stress magnitude determined by the strain recovery method was within 2 MPa of an open-hole hydraulic fracture stress measurement.

0204 Processing

REFER ALSO TO CITATION(S) 31308

31402 **Hydrodesulfurization by reduced molybdenum sulfides: Activity and selectivity of Chevrel phase catalysts.** McCarty, K.F.; Schrader, G.L. New York, NY; American Institute of Chemical Engineers (1985). 10p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract W-7405-ENG-82.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Chevrel phase compounds (M/sub X/Mo_6S_8) have been investigated for activity for the hydrodesulfurization of thiophene at 400°C. Catalysts with ternary metals such as Co, Fe, Pb, Cu, and Ho were found to have comparable or greater activity for desulfurization compared to typical model industrial catalysts. Hydrogenation activity for 1-butene was relatively low.

0205 Products And By-products

REFER ALSO TO CITATION(S) 32516

31403 **(AD-A—164045/7/XAB) Development of a fuel-spill/vapor-migration modeling system. Final report, October 1984-March 1985.** England, W.G.; Teuscher, I.H. (Tracer Technologies, Inc., Escondido, CA (USA)). Dec 1985. 111p. NTIS, PC A06/MF A01.

The system of handling aircraft fuels and/or missile propellants can be subject to failure. Such system failures could result in a fuel/propellant spill and subsequently result in the release of potentially explosive or toxic vapors into the atmosphere. The results of the Phase I effort included a review of Air Force experience in aircraft-fuel spills and the development of models to predict the vapor generation and migration of fuel spilled or sprayed into the atmosphere. These models were then applied to typical sizes of spills and estimates made of the hazard region around the spill. The results of the effort include an identification of the important parameters that influence the mathematical modeling results and estimates of the hazard region. The projected hazard region is somewhat smaller than present regulations require.

31404 **(AD-A—164256/0/XAB) Oxidation and gum formation in diesel fuels. Interim technical report, May-December 1985.** Mayo, F.R. (SRI International, Menlo Park, CA (USA). Chemistry Lab.). 20 Dec 1985. 28p. NTIS, PC A03/MF A01.

This Report describes experiments on oxidation and gum formation from n-dodecane, tetralin, and several diesel fuels at 43, 60, and 100 C, with and without added initiators, t-butyl peroxide and 2,2'azobis(2-methylpropionitrile) (ABN). Experiments on gum determination and a manuscript for publication, Gum and Deposit Formation from Jet Turbine and Diesel Fuels at 100 C, are included. One objective of work on this Contract is to relate oxidations of diesel fuels at 100 and 130 C, where experiments can be performed in hours or days, to standard tests for fuel stability at ambient temperatures and 43.3 C (110 F), which require many weeks. A second objective is to devise a fast test for fuel stability.

0206 Health And Safety

31405 **(PB—86-928600/XAB) International energy statistical review. Monthly report.** (Central Intelligence Agency, Washington, DC (USA)). 1986. vp. NTIS.

Subscription.

The International Energy Statistical Review provides current information and comparisons with recent years for a variety of topics on international energy; almost all concern some aspect of the petroleum and natural gas industries. Six charts deal respectively with total Free World oil production, OAPEC oil production, non-Arab oil production, Free World and USSR oil production, inland oil consumption, and net oil imports. In general, the time period covers the last four or five years. The remainder of the Review is made up of 31 tables, covering such disparate topics as production, capacity, reserves, trade, consumption and stocks. Areas covered include the world, Free World, OPEC, OAPEC, OECD, selected developed countries, Western Europe, China, USSR, and Eastern Europe.

0207 Marketing And Economics

REFER ALSO TO CITATION(S) 31374, 32018, 32028

31406 **(DOE/EI/10464—T3) [Oil and gas investment and profitability projections. Final report].** (ICF, Inc., Washington, DC (USA)). [1986]. Contract AC01-79EI10464. 25p. NTIS, PC A02/MF A01 - GPO; GPO Dep. File Number DE86010344.

The Capital Formation submodel of the mid-term Oil and Gas Supply Modeling System (MOGSMS) is designed to provide the supply models with period-by-period adjustments in the domestic petroleum industry's cost of capital which might have an effect on the quantity of investment that the supply models would otherwise choose to undertake. This feature adds to the soundness of the economic foundations of the supply modeling system by making the industy's prospective investments in domestic oil and gas exploration and development reflect accurately the costs of capital, the costs of capital structure adjustments, and the opportunity cost of using these funds elsewhere in the economy. The submodel provides these period-by-period adjustments in captial costs by measuring the effects on industry capital structure of the quantities and timing of investments implied by the price and resourse related calculations of the drilling profile submodel of MOGSMS. The effect of these adjustments in capital structure is to alter the industry's respective costs of equity and debt, which can then be combined into an updated cost of capital. This new measure, which reflects investment and capital formation history up to each year in the forecast period, is sent back to the supply models to be used as the relevant discount rate for the next year's price- and resource-related calculations of exploration and development activity.

31407 **(DOE/EIA—0109(86/02)) Petroleum supply monthly, February 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). 23 Apr 1986. 105p. NTIS, PC A06/MF A01; 1 - GPO; GPO Dep. File Number DE86009681.

31408 **(DOE/EIA—0202(86/2Q)) Short-term energy outlook. Quarterly projections, April 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). Apr 1986. 47p. NTIS, PC A03/MF A01; 1 - GPO; GPO Dep. File Number DE86010274.

Despite significant drops in world oil prices, US demand for petroleum products in the base case is projected to increase by only 2.7% between 1985 and 1986, to 16.1 million barrels per day. Lower prices and higher personal income are expected to result in gasoline demand this summer at levels not seen since 1978, with travel demand up by nearly 5% this driving season over the year-earlier level. The dramatic decline in residual fuel oil consumption

experienced over the past 8 years is expected to slow in 1986, mainly because of stronger demand at electric utilities. Domestic production of crude oil is expected to fall slightly in 1986. (The base case assumptions and projections are summarized in Table 1 on page 5.) Additional highlights of the base case are forecast. 8 figs., 18 tabs.

31409 **(DOE/EIA—6010275) Impact of lower world oil prices and alternative energy tax proposals on the US economy.** (USDOE Energy Information Administration, Washington, DC). 18 Apr 1986. 71p. NTIS, PC A04/MF A01; 1 - GPO; GPO Dep. File Number DE86010275.

The first part of the study presents the outlook for world oil prices. The second part of the study presents an analysis of the effects of a $10 per barrel drop in world oil prices on the domestic economy and on domestic energy markets through 1995. The third part of the study presents an analysis of four alternative energy taxes: a $5 per barrel oil import tariff; a tax on motor gasoline and diesel fuel; a tax on all petroleum products; and a tax based on the energy content of natural gas and oil products. This study is based on results using the Energy Information Administration's Intermediate Future Forecasting System (IFFS) models and the Data Resources, Inc. (DRI) quarterly model of the US economy. Because the analysis is based on assumptions provided by the requestor and has not received formal Energy Information Adminstration review, this report does not represent an official Energy Information Administration product. The Energy Information Administration certifies only that the relevant ocmputer models were run as described and operated as designed.

31410 **(PB—86-156387/XAB) Economic perspectives on regional energy development issues. Working paper.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Nov 1984. 50p. NTIS, PC A03/MF A01.

The U.S. Office of Technology Assessment is conducting a study of potential technological responses to a large and permanent oil price rise due to a disruption in oil imports of three to four million barrels per day. The major objectives of the study are to ascertain how much oil can be displaced and how quickly in such a crisis, and to estimate what ameliorating effects the oil displacement might have on the economic impacts of the oil price rise. One of the issues related to this assessment is the relationship between regional and national impacts of various oil displacement options. Clearly, regions of the country will be affected differently by the selection of oil displacement technologies just as they are differentially impacted by oil price increases. For example, adoption of enhanced oil recovery clearly would have different regional (and probably national) impacts from adoption of grain alcohol production. The major objective of this issue analysis is to delineate and clarify some of the major issues, tradeoffs, and value judgements associated with the analysis of regional impacts of oil displacement options.

31411 **Energy outlook for the eighties.** Montgomery, D.W. (Dept. of Energy, Washington, DC). *Energy Technology (Washington, D.C.);* **12**: 54-57(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Energy Information Administration (EIA) forecasts assume a 3.1% annual economic growth between 1985 and 1990 and a 2.3% rate between 1990 and 1995. Current projections are for lower prices and higher consumption for petroleum and little change in natural gas markets. Total energy consumption is expected to grow by 2% between 1985 and 1990, with energy consumption per dollar of gross national product declining at about 1% per year. These projections are lower than those made previously because of the drop in world oil prices, the renewed strength in energy-intensive industries, and a strong trend toward electrification.

0208 Waste Management

31412 **Waste hydrocarbons recycling.** Brinkman, D.W. (National Institute for Petroleum & Energy Research, Bartlesville, OK 74005). *Chemical Engineering Progress;* **82**: No. 3, vp(Mar 1986).

During the 1970s, the U.S. supply of petroleum was predicted to be quickly vanishing. The price we would have to pay for what remained would be unprecedented. All alternatives would not only have to be explored, but exploited to their fullest potential. In that decade of recycling aluminum cans, glass bottles, and newspapers by the truckloads, the recycling of petroleum products that had become contaminated, oxidized, or otherwise made unsuitable for their intended use seemed so obvious as to be trivial. Indeed, the level of interest in recycling petroleum products in the 70s was reflected on the quantity of research performed, papers published and patents granted. More than 1,200 reports, patents, and other technical publications were recently documented for this rather narrow subject. And the potential would seem to justify this level of interest. A table shows some of the major waste of used petroleum streams available in the United States alone. Many of these streams represent highly refined products into which we have already invested considerable time and energy. Can these products be recovered for a relatively low additional investment in time and energy? Examples addressing the two largest categories - used lubricating oil and contaminated fuels - are discussed here.

0209 Environmental Aspects

REFER ALSO TO CITATION(S) 31394, 31395, 32725

31413 **(ORNL—6251) User's manual for ecological risk assessment.** Barnthouse, L.W.; Suter, G.W. II (eds.). (Oak Ridge National Lab., TN (USA)). Mar 1986. Contract AC05-84OR21400. 222p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86010063.

This report presents the results of a four-year project on environmental risk analysis of synfuels technologies. The overall objective was to develop a risk assessment methodology capable of: (1) ranking the waste streams in a process by risk to the environment; (2) estimating the change in environmental risk that would be achieved using alternative control technology options; (3) estimating the sensitivity of risk estimates to site-dependent variables; and (4) identifying research problems contributing the greatest uncertainty to risk estimates. An initial suite of five potentially useful techniques was applied in a preliminary risk analysis of indirect coal liquefaction technologies. As a result of this application, it was determined that two of the original five techniques were unsuitable for synfuels risk assessments. The remaining three were developed further and applied in a unit-release risk assessment, a revised indirect liquefaction risk assessment, a direct liquefaction risk assessment, and an oil shale risk assessment. This users' manual is intended to facilitate wider use of ecological risk analysis techniques by: (1) presenting the rationale for the approach developed in this project; (2) describing the derivation and mechanics of the three techniques used in the synfuels risk assessments; and (3) discussing the limitations and other potential applications of ecological risk assessment methods.

31414 **Burrowing behavior of sand lance, Ammodytes hexapterus: effects of oil-contaminated sediment.** Pearson, W.H.; Woodruff, D.L.; Sugarman, P.C.; Olla, B.L. (Battelle, Marine Research Lab., Sequim, WA). *Marine Environmental Research;* **11**: 17-32(1984).

While foraging in the water column for zooplankton, sand lance, Ammodytes hexapterus, are under heavy predation from marine birds and fish. To avoid predation, sand lance bury in the sand when not foraging and during overwintering. The authors did two experiments to determine whether oil contamination of the sand would reduce the amount of time that sand lance spent buried. In the first experiment (June, 1980) sand lance significantly decreased by 20% the time spent buried in oiled sand (306 ppm). In the second experiment (June, 1981) sand lance did not decrease time spent buried in oiled sand at 28 and 256 ppm but did at 3384 ppm. The higher condition index of the 1981 fish suggested that nutritional state may have influenced how sand lance used the sediment as a refuge and how they responded to contamination of that refuge. 32 references, 2 figures, 5 tables.

0220 Transport, Pipelines, And Handling

REFER ALSO TO CITATION(S) 32867

0230 Properties

REFER ALSO TO CITATION(S) 32132

0240 Storage

31415 (BMFT-FB-T—85-156) Laboratory investigation for determination of the hydraulic fracture gradient in salt. Final report. Kiersten, P.; Schlueter, K. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 146p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752001.

For the operation of cavities in salt rock the necessary as well as the maximum permissible internal pressure inside the cavity are of the highest interest. If the inner pressure psub(i) exceeds a critical limit of pressure psub(c) fracturing of the cavity-wall will start, and the cavity will start to leak. Laboratory tests on cylinders of salt rock with a borehole are to show how the critical pressure psub(c) depends on the test parameters. The strain around the borehole has great influence on the internal pressure psub(c) as well as on the pressure rate at which the liquid is presented into the borehole. The existence of a critical pressure rate dpsub(ic)/dt is proved. A further influence in factor of the fracturing pressure is the viscosity of the frac-liquids used. A limiting value is determined long-term tests with increased internal pressure. Below this limit there is no progress of fracturing. The experiments were carried out with different kinds of salt. (orig.). With 69 refs., 53 figs.

31416 Physical and numerical simulations of fluid-filled cavities in a creeping material. Preece, D.S.; Sutherland, H.J. (Sandia National Labs., Albuquerque, NM). pp 507-514 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—). Contract AC04-76DP00789.

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

The finite element method has been used for several years to calculate the creep closure of Strategic Petroleum Reserve (SPR) storage cavities in rock salt. The two-dimensional axisymmetric finite element calculations performed thus far have required many simplifying assumptions to reduce the three-dimensional cavern geometries to two dimensions (Preece and Foley. 1984). Centrifuge testing has been employed to qualify the finite element program on a well-controlled laboratory experiment which bears resemblance to an oil-filled cavern in rock salt. Centrifuge testing produces an acceleration induced geostatic stress field around the cavity similar to that around an actual cavity in rock salt. The three centrifuge experiments reported here were single cavity tests which were performed at three different accelerations and employed the creeping material plasticine. Plasticine was used because it gives measurable cavity closure in a reasonable centrifuge test time. These preliminary experiments had two purposes: 1) explore the feasibility of creep testing on the centrifuge, and 2) provide an experiment with well-controlled boundary conditions and material properties for qualifying a two-dimensional axisymmetric finite element computer program with creep capability. The single cavity centrifuge experiments and the attending two-dimensional finite element analyses are presented in this paper.

0250 Combustion

REFER ALSO TO CITATION(S) 32132

31417 A diesel combustion bomb: Proof of concept. Oren, D.C.; Wahiduzzaman, S.; Ferguson, C.R. Warrendale, PA; Society of Automotive Engineers, Inc. (1984). 16p. (SAE-TP—841358).

A combustion bomb has been developed which allows simulation of diesel combustion without the need to heat the bomb to high temperatures. Simulation of the compression stroke is achieved by burning a lean precharge composed of acetylene, oxygen and nitrogen. By controlling the initial partial pressures of these constituents it is possible to burn them to a state with an oxygen concentration, temperature and pressure representative of conditions in a diesel engine at the start of fuel injection. Diesel fuel injected into these gases autoignites and burns in a manner typical of combustion in diesel engines.

03 NATURAL GAS

0302 Geology And Exploration

REFER ALSO TO CITATION(S) 31353, 31386, 31387, 31439, 31440, 31441, 31445, 31446, 31447, 31453, 31454, 31456

31418 (DOE/METC—86/0231) Eastern gas shales. Technology status report. (USDOE Morgantown Energy Technology Center, WV). Jan 1986. 21p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86001038.

The goal of eastern gas shales research is to develop the scientific and engineering knowledge base on the recovery of natural gas from shale formations that underlie the Appalachian, Illinois, and Michigan Basins. Currently, research focuses on fundamental reservoir properties from wells of opportunity, and on the installation of a second offset well test site for understanding reservoir flow behavior. This research entails gathering reservoir property data from 10 sites that have favorable geology and geochemistry in areas of nonestablished production. This information will quantify the magnitude of matrix and fracture porosity and permeability and reservoir anisotropy, and will improve the ability to quantify technically recoverable resources for these areas of unknown potential. Also under study are methods to increase recovery efficiency from a directionally drilled well in an area of historical production, wherein less than 10% of the available gas-in-place is typically produced by stimulated vertical wells. Analysis of shale gas production mechanisms indicates that an increase in the amount of surface area connected to the borehole may result in more of the adsorbed gas being released and produced over the entire life of the well. Increased recovery efficiency is thought to be achievable using a directionally deviated well that can be designed to cross natural fractures and can be stimulated to increase the surface area in contact with the borehole. The existing reservoir model (SUGAR-MD) has been modified to permit the expected performance of stimulated, deviated wells to be simulated. The drilling, coring, logging, and testing of a directionally deviated well is a major field verification effort that measures the key reservoir properties used in the simulator and also the productivity improvement over that of stimulated vertical wells in the area. 7 refs., 6 figs., 3 tabs.

31419 (DOE/METC—86/6034, pp 4-10) **Ordovician black shales: Devonian shale-oil study.** Roen, J.B.; De Witt, W. Jr.; Claypool, G.E.; Wallace, L.G. (Geological Survey, Reston, VA). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AI21-83MC20422.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objectives of this project are to evaluate the hydrocarbon potential of the organic-rich Ordovician shales of the Appalachian basin and to determine if the Devonian shales of the Appalachian basin were the source beds for the petroleum found in the closely associated reservoirs of Devonian and Mississippian age. The evaluation of the Ordovician shales in regard to their hydrocarbon potential will focus primarily on stratigraphic delineation, subsurface mapping and geochemical analyses of available subsurface and surface samples. The Devonian source bed-oil studies includes the collection of critical oil samples from reservoirs of known stratigraphic position and the collection of Devonian black shale samples also from known stratigraphic position from cores taken within reasonable distances of the known reservoirs. An additional but not a critical objective to the shale evaluation or the source bed study is a comparison of various geochemical and other

techniques used to characterize the organic rich shales. 3 references.

31420 (DOE/METC—86/6034, pp 11-23) **Measurement and study of stress variations within the Appalachian Basin of western New York.** Evans, K.F.; Engelder, T. (Columbia Univ., New York, NY). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC21-83MC20337.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

Given an existing fracture population, there are firm physical grounds to suppose that fracture porosity and permeability are strongly influenced by the contemporary in-situ stress field through the influence it asserts upon effective fracture aperture. Given this it would seem that attractive target zones for gas production would be naturally fractured shale reservoirs where the least horizontal principal stress is markedly sublithostatic. The investigators have undertaken a detailed study of in-situ stress variations that occur laterally on scales of kilometers and vertically on the scale of less than 10 meters in a horizontally-bedded section of Devonian shales in Western New York. Detailed stress profiles were obtained in three boreholes a few kilometers apart, each of which presented an open hole section from the Dunkirk formation to below the Tully limestone, a section identical to that cored in EGSP well NY#1 which lies 20 km northwest of the study area, Figure 1. The measurements were made using a new wireline-based minifracturing tool owned and modified for the project by Columbia University. As the wells are uncased, maximum as well as minimum horizontal stress magnitudes can be estimated. Fieldwork was completed on 10th November and data analysis is still in progress. Consequently only obtained minimum horizontal stress data will be discussed in this report. 7 references, 6 figures.

31421 (DOE/METC—86/6034, pp 24-30) **Eastern gas shales lineament analysis.** Mercer, J.C. (Morgantown Energy Technology Center, WV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of this project is twofold. The primary objective is to conduct a geostatistical analysis in three areas of different tectonic stress within the Appalachian Basin to determine if lineaments affect the production of Devonian shale gas wells. The secondary objective is to compare and contrast the maps provided by three experienced lineament mappers to establish if any of the various techniques used to identify lineaments are more effective at locating subsurface fracture zones in the Devonian shale. Investigator A used low altitude aerial photos, LANDSAT thermatic map imagery, topographic maps, and geologic maps for lineament identification. Investigator B utilized LANDSAT 3 imagery and NASA high altitude (U-2) aerial photos while Investigator C employed enhancement techniques to enlarge LANDSAT 3, LANDSAT thematic maps, and U-2 photos for lineament definition. 4 figures.

31422 (DOE/METC—86/6034, pp 111-119) **Geologic characterization of tight gas reservoirs, Greater Green River Basin.** Law, B.E.; Spencer, C.W.; Lickus, M.R.; Dickinson, W.W.; Pollastro, R.M. (Geological Survey, Denver, CO). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AI21-83MC20422.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

A wide variety of methods are being used to geologically characterize tight gas reservoirs and resolve resource assessment and recovery technology problems. These methods include surface and subsurface stratigraphic studies, paleoenvironmental interpretation, micropaleontologic analysis, organic geochemical and thermal maturation studies, origin of gases, subsurface-pressure mapping, core-to-well-log correlation, and analysis of regional natural-fracture trends. The reservoir rocks are being characterized using optical petrography, scanning electron microscopy, X-ray diffraction, and electron probe. Other studies include analysis of stable isotopes of oxygen and carbon, fission-track annealing, and fluid inclusions. Results to data are presented. 19 references, 4 figures.

31423 (DOE/METC—86/6034, pp 120-129) **Geologic characterization of tight gas reservoirs, Piceance Basin.** Spencer, C.W.; Johnson, R.C.; Nuccio, V.F.; Pitman, J.K.; Pollastro, R.M. (Geological Survey, Denver, CO). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AI21-83MC20422.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The Major objectives of the USGS MWX (Multiwell Experiment) work are to provide geologic characterization and related research in support of the ongoing petroleum engineering, petrophysical, log analysis, and well stimulation work at MWX. A critical additional goal is to characterize the geologic conditions at the MWX site. This characterization can be correlated to other parts of the Piceance Basin and, more importantly, to analog basins so that the research results at MWX will have broad application to the identification of, and the enhanced recovery of gas from tight reservoirs elsewhere in the US. Specific objectives of this work are to characterize the geologic setting of the MWX site in terms of its (1) regional structure and general stratigraphy, (2) tectonic history, (3) gas generation and migration, (4) mineralogic and petrologic character of the reservoirs, (5) microscopic character of porosity and permeability, and (6) the relationship of these factors to log analysis and well stimulation recommendations. Results to date are presented. 15 references, 5 figures.

31424 (DOE/METC—86/6034, pp 130-136) **Multiwell Experiment site geology.** Lorenz, J.C. (Sandia National Labs., Albuquerque, NM). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC04-76DP00789.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of the site geology study for the Multiwell Experiment project is the detailed geologic characterization of the Mesaverde low-permeability reservoirs. This characterization includes obtaining data on the external morphology (size, shape, and orientation) of the reservoirs penetrated by the MWX wells so that reservoir volumes and interactions with both natural and hydraulic fractures could be assessed; and the internal characteristics of the reservoirs (distribution of permeability barriers and fractures), so that reservoir production behavior could be properly modeled. Results and future research activities are described. 11 references, 4 figures.

31425 (DOE/METC—86/6034, pp 137-150) **Rock matrix and fracture analysis of flow in western tight gas sands.** Morrow, N.R. (New Mexico Institute of Mining and Technology, Socorro). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC21-84MC21179.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The Department of Energy has been studying the western tight gas sands as a source of natural gas for several years. These sands are characterized as having very low porosity and permeability. Results of the research to date indicate that the flow conditions in the reservoir are greatly enhanced by the presence of natural fractures, which serve as a transport mechanism for gas from the less permeable rock portions. The major problem is that of efficiently extracting the gas from the reservoir. Gas production could be enhanced by stimulating the reservoir. Studies have shown that the fracture design is strongly influenced by the rock matrix properties. Computer models for simulating this stimulation require accurate input data. The objective of the proposed work is to obtain accurate (reliable) measurements of the tight gas sands matrix and fracture parameters through laboratory core analysis. Results to date are presented. 8 references, 2 figures, 5 tables.

31426 (DOE/METC—86/6034, pp 185-193) **Crosswell acoustic imaging project.** Albright, J.N.; Johnson, P.A.; Phillips, W.S. (Los Alamos National Lab., NM). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

During August 1984 an extensive crosswell acoustic survey was undertaken at the MultiWell Experiment (MWX) site near Rifle, Colorado using borehole tools developed in support of DOE geothermal programs at Los Alamos National Laboratory. Roughly a quarter-million signals were transmitted between the three wells that penetrate the coastal zone lenticular gas sands, beginning beneath the Red sands and extending up past the fractured Purple sands. These measurements represent by far the most extensive crosswell acoustic data set in existence and the first such taken in gas-bearing sands. The high-frequency acoustic signals of which a survey is comprised are not contaminated by passage through the coastal zone overburden. At the MWX site this enables a dissection of the fine structure of lenticular sands in the coastal zone that is not possible with any other seismic technique. Rock properties are measured away from the wellbore and in the direction of production flow. Thus, for example, steeply dipping permeability boundaries disrupted or not penetrated by drilling may be detected through crosswell measurements. Finally, since interpretation in exploration seismology and crosswell acoustics have a common basis, application of the plethora of seismic processing technology to crosswell data can be expected to yield immediate useful results. Although the potential for crosswell acoustics is widely recognized, the comparatively little work underway nationally concentrates on theoretical studies of simulated data, and thus a large gap exists between theory and practice. In this context the MWX surveys provide a badly needed data set. 19 references, 3 figures.

31427 **Predictions of size and orientations of Lenticular reservoirs in the Mesaverde group, Northwestern Colorado.** Lorenz, J.C. (Sandia National Labs.). pp 23-32 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—).

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

Reservoirs deposited in a delta plain environment as part of the Mesaverde Formation have been penetrated by the three wells of the U.S. Department of Energy's Multiwell Experiment (MWX) in the east-central Piceance Creek basin, northwestern Colorado. These reservoirs are gas-bearing, low-permeability, sandy channel and splay deposits. Tight well spacing and an abundance of quality data from the MWX project make it possible to estimate reservoir width and orientation. Estimates of lens width were made independently by two techniques: 1) a well-to-well correlation/probability method, and 2) by analogy to height-to-width ratios of similar lenses exposed in surface outcrops. Estimates of lens trends were made using a combination of crossbedding in oriented core, crossbedding indicated by experimental high resolution dipmeter tool, and the spatial arrangements of lens thicknesses and channel subenvironments as recognized in core and logs. Splay deposits, recognized as a different suite of lithologies and sedimentary structures in core, have less easily defined boundaries, but limits can be placed on their general position.

31428 **Comprehensive well testing and modeling of pre- and post-fracture well performance of the MWX lenticular tight gas sands.** Cipolla, C.L.; Lee, S.J.; Branagan, P.T.; Wilmer, R.H. (CER Corp.). pp 191-202 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—).

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

Well testing and reservoir analysis results from the Department of Energy's Multiwell Experiment (MWX) are presented before and after a set of hydraulic fracturing treatments were performed in two naturally fractured, lenticular Paludal sands of the Mesaverde Group in the Rulison Field, Colorado, The well testing data combined with seismic, core, log, production, and special fracture diagnostics information was integrated into a reservoir model that was used to assess the effects of various reservoir parameters on well performance before and after each fracture treatment. Production/interference testing and the subsequent reservoir modeling revealed that although hydraulic fracturing produced a highly conductive linear flow path to the wellbore, the productive fracture lengths appeared to be considerably shorter than designed lengths. Furthermore, a post-frac decline in overall production implied a degrading effect upon the flow capacity of the original natural fracture system that was adjacent to the propped fracture. The production/interference testing illustrates the gradual degradation in the near term production capacity of the reservoir from its initial state through two hydraulic fracture treatments.

31429 **In-situ physical properties using crosswell acoustic data.** Johnson, P.A.; Albright, J.N. (Los Alamos National Lab.). pp 311-320 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—).

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

Crosswell acoustic surveys enable the in situ measurements of elastic moduli, Poisson's ratio, porosity, and apparent seismic Q of gas-bearing low-permeability formations represented at the Department of Energy Multi-Well Experiment (MWX) site near Rifle, Colorado. These measurements, except for Q, are compared with laboratory measurements on core taken from the same depths at which the crosswell measurements are made. Seismic Q determined in situ is compared to average values for sandstone. Porosity was determined from crosswell data using the empirical relationship between acoustic velocity, porosity, and effective pressure developed by Domenico. In situ porosities are significantly greater than the core-derived values. Sources of the discrepancy may arise from (i) the underestimation of porosity that can result when Boyle's Law measurements are made on low-permeability core and (ii) the application of Dominico's relationship, which is developed for clean sands, to the mixed sandstone and shale lithologies represented at the MWX site. Values for Young's modulus and Poisson's ratio derived from crosswell measurements are comparable to values obtained from core. Apparent seismic Q measured in situ between wells is lower than Q measured on core and clearly shows the heterogeneity of sandstone deposited in a fluvial environment.

31430 **Fracturing and testing case study of paludal, tight, lenticular gas sands.** Warpinski, N.R.; Branagan, P.T.; Sattler, A.R.; Lorenz, J.C.; Northrop, D.A.; Mann, R.L.; Frohne, K.H. (Sandia National Labs.). pp 267-278 of 1985 SPE/DOE joint symposium on low permeability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—). Contract AC04-76DP00789.

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

This paper is a case study of the stimulation and testing of tight lenticular sands in the paludal interval of the Mesaverde Group in the Piceance basin at DOE's Multiwell Experiment site in Colorado. Prestimulation data acquired include (1) geologic studies which delineate the size and shape of the lenses, (2) detailed core reservoir/rock property data, (3) stress test data showing the vertical distribution of stress through the interval, (4) drawdown, buildup, and interference tests which provide in situ reservoir properties, and (5) laboratory data on frac fluid invasion and damage. Stimulation of the zone was conducted in two phases. The first phase consisted of step-rate/flowback tests and two minifracs in which prefrac design information was obtained. The main stimulation was the second phase and it consisted of 75,000 gal (284 m^3) of cross-linked HPG and 193,000 lbs. (87,545 kg) of sand. Bottomhole pressure and temperature, as well as all surface data, were obtained and borehole geophones were used for fracture diagnostics. Detailed pre-frac, between-frac, and post-frac well test programs were conducted in conjunction with the stimulation. Severe cleanup problems and remedial actions are documented. The analyses and diagnostics give some indication of fracture geometry in this lenticular environment. Complications such as high treatment pressures and frac-fluid damage are detailed. Gas production was decreased (at least over short test periods) by both phases of the treatment; this was probably due to damage to the natural fractures which did not have sufficient time to clean up.

31431 **Capillary pressures and gas relative permeabilities of low permeability sandstone.** Ward, J.S.; Morrow, N.R. (New Mexico Petroleum Recovery Research Center). pp 321-334 of 1985 SPE/DOE joint symposium on low permiability reservoirs. Dallas, TX; Society of Petroleum Engineers (1985). (CONF-8505115—). Contract AC21-84MC21179.

From SPE/DOE symposium on low permeability reservoirs; Denver, CO, USA (19 May 1985).

Use of a high-speed centrifuge for capillary pressure measurements on low permeability sandstones has been investigated. Curvatures for sandstones has been investigated. Curvatures for air-brine and air-decane displacements are compared. Capillary pressures of up to about 800 psi for gas displacing brine were extended over an order of magnitude by measurement of isotherms for desorption of water. Capillary pressures measured by high-speed centrifuge merged satisfactorily with results derived from the desorption isotherms. No distinct irreducible water saturation was observed. Permeabilities to gas at various levels of water saturation were also measured and found to be generally consistent with previous relative permeability measurements.

0303 Drilling, Production, And Processing

31432 (DOE/METC—86/6034, pp 31) **Eastern gas shales reservoir tester instrumentation development.** Lawson, L.O.; Fasching, G.E.; Keech, T.W. Jr. (Dept. of Energy, Morgantown, WV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

Gas wells in Devonian shale and other typically tight sands of the Appalachian Basin are often low producers from a single interval but are economically viable due to multiple interval production. Production well testing is desirable to evaluate reserve capacity, to provide data for emphasizing more productive intervals in well completions, and to diagnose production problems such as premature and abrupt production decline. Data used by Government, universities, and industry today are usually the total initial open-well flows and measurements from the combined, multiple producing regions of the wellbore. Open flow data is of limited value for interval-specific research purposes. The diagnostic technique under development will determine, for isolated intervals, the interval production characteristics and vertical interference characteristics from measured flow rates at controlled back pressures using a downhole wireline tool. The objective of the work being performed by the Instrumentation Sciences Branch at the Morgantown Energy Technology Center during the 1985 fiscal year has been to design the control, power, data acquisition, and communication systems for the Downhole Reservoir Tester (DRT). The purpose of the DRT is to isolate selected gas producing intervals from within cased or uncased wells, to conduct controlled pressure and flow measurements, and to retrieve uncommingled samples. Hydraulically operated straddle packers are to be used to isolate the test intervals. Electric motors are to power the pumps and valves within the tool. Computers on the surface perform remote control and data logging functions.

0305 Health And Safety

REFER ALSO TO CITATION(S) 32151

0306 Marketing And Economics

REFER ALSO TO CITATION(S) 31405, 31406, 31411, 31460, 31461, 31754, 32018, 32109

31433 **(PB—86-168721/XAB) Vulnerability of industrial natural-gas markets to electricity and coal: a context for R and D planning. Working paper.** Lerner, M.O.; Kothari, V.S.; Salama, S.Y. (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). 1 Nov 1982. 56p. NTIS, PC A04/MF A01.

Current trends in electric- and coal-technology developments and the outlook for natural-gas prices indicate the possibility of strong competition and possible natural-gas market-share losses in the industrial sector. The report develops an initial classification of industrial energy-consuming processes and estimates the extent to which future natural-gas consumption in each class is vulnerable to competition from electricity and coal. The discussion also addresses reasons why specific gas markets are considered vulnerable.

31434 **Financial and regulatory issues of packaged cogeneration.** Zimmer, M.J. *Energy Technology (Washington, D.C.);* **12**: 131-150(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

A checklist of basic considerations in developing a packaged cogeneration system covers financial, regulatory and legal, and a variety of specialized issues. The authors see a window of opportunity until 1989 for major packaged cogeneration expansion. Unless the gas industry responds more creatively, the remaining market for gas utilities by 1990 may be for small units and heavily reliant on commercial and packaged systems. Declining gas prices will create an opportunity and potential environment for long-term supply agreements. Innovative tariffs and rate design will reflect the load balancing, high load factor attributes of gas-fired cogeneration at the distribution company level. Natural gas-fired cogeneration will be marketed from within the industry through diversified, unregulated pursuits. 4 figures, 1 table.

31435 **Industrial pricing of natural gas: the historical perspective.** Marston, P.M. (Federal Energy Regulatory Commission, Washington, DC). *Energy Technology (Washington, D.C.);* **12**: 324-331(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

History suggests that the participants in the gas industry, including the regulators, may have to wrestle with the economic and equitable imperatives of industrial natural gas pricing under changing market conditions for some time to come. The author traces the developing of natural gas prices, regulation, and the current deregulation from a regulators point of view. He notes a return to flexible pricing for unregulated fuels, as well as the development of downstream storage capability, major changes in the nature of industrial uses, and changes in the type of competition over the past 50 years.

31436 **International comparison of residential gas use and conservation.** Schipper, L.; Ketoff, A. (Lawrence Berkeley Lab., CA). pp 496-510 of Proceedings of the International Gas Research conference. Rockville, MD; Government Institutes, Inc. (1980).

To understand the historical development of residential energy use in a variety of countries and to explain the variations in terms of differences in economic structure and energy intensity, LBL assembled and examined energy-use data for seven OECD countries (the UK, Canada, West Germany, Italy, France, Sweden, and Japan), other developed countries, and certain key developing countries (for instance, Kenya and the Republic of Korea). The study focused on the factors that influence the quantity of gas used, such as economic and lifestyle indicators, ownership of equipment, the energy intensity of the equipment utilization, gas prices, and the potential for conservation. Since 1960, gas central heating has spread rapidly everywhere except Japan; water heating is the other major residential use of gas. The increased saturation of gas appliances, along with a trend toward more dwelling room per person, accounts for most of the observed increase in gas use in the 1960s; nevertheless, preliminary figures suggest that since 1972, after a marked rise, the consumption of gas per task has stabilized.

0309 Artificial Stimulation

REFER ALSO TO CITATION(S) 31338, 31353, 31387, 31399, 31401, 31418, 31422, 31423, 31424, 31425, 31428, 31430

31437 (DOE/METC—86/6034, pp 1-3) **Overview: Eastern gas shales.** Yost, A.B. II. (Dept. of Energy, Morgantown, West Virginia). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

Prior year efforts in Eastern Gas Shales research have been successful in characterizing the geology, geochemistry, and resource magnitude within the Appalachian Basin and in defining the gas-producing mechanism and drainage pattern in an established area of production near the middle of the basin. Currently research is focused on activities related to the acquisition of fundamental reservoir properties from wells of opportunity and the installation of a second offset well test site for understanding reservoir flow behavior. Other ongoing areas of research include geologic evaluation of Ordovician shales, detailed in situ stress measurement by well line methods, development of improved hydraulic fracturing code, hydraulic/natural fracture interaction studies, field optimization models, and data base development.

31438 (DOE/METC—86/6034, pp 32-41) **Analysis of fracturing mechanisms in naturally fractured rocks.** Blanton, T.L. (Science Applications International Corp., Evergreen, CO). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC21-83MC20289.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The overall objective of this project is to provide a basis for selecting fracturing treatments that will cross and connect as much of the natural fracture system to the wellbore as possible. Tapping the natural fracture system has been recognized as essential to obtaining significant well stimulation. The work is divided into three groups of tasks: to determine the type of interaction that can be expected between induced and natural fractures under various in-situ conditions; to develop data on in-situ conditions that are required for application of the criteria in the field; and to synthesize the results of the first two groups into a field-applicable determination of the type of interaction that can be expected from different fracturing treatments in different parts of the basin. 31 references, 2 figures, 1 table.

31439 (DOE/METC—86/6034, pp 42-52) **LLNL unconventional gas/Eastern Devonian shale research.** Heard, H.C.; Hearst, J.R.; Lin, W.; Mao, N.H.; Nilson, R.H.; Swift, R.P. (Lawrence Livermore National Lab., CA). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract W-7405-ENG-48.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of the LLNL Eastern Devonian Shales (EDS) subprogram is to provide better models and better diagnostics for the stimulation of tight shale reservoirs, with an emphasis on dynamic or tailored-pulse loading (TPL), and on geological reservoir characteristics such as rock properties, in-situ stresses and location of natural fractures. There were five tasks under EDS research in FY 1985: (1) continued development of a seismic reflection approach to locating natural fractures which do not interact a well; (2) continued development of a tool to estimate in-situ stresses around gas wells, by measuring shear-wave velocity anisotropy induced by rock stresses; (3) application of geostatistical (kriging) methods to analyze geological and gas production data from West Virginia shales; (4) development of a dynamic numerical model to represent the interaction of gas-driven fractures with natural fractures, in shale reservoirs; and (5) documentation of previously measured mechanical and sonic properties of West Virginia shales, up to the very high pressures (GPa's) encountered in dynamic/propellant stimulation. Results from these studies are presented. 16 references, 9 figures.

31440 (DOE/METC—86/6034, pp 53-62) **Installation of a Devonian shale reservoir testing facility and acquisition of reservoir property measurements.** Kirr, J.N.; Locke, C.D. (BDM Corp., McLean, VA). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The research objective is to gather and analyze geologic and production data on the Devonian-age Rhinestreet - Marcellus shales within ten specific target areas in the Appalachian, Michigan and Illinois Basins. Data will be obtained from cores, logs and production testing of nine single wells of opportunity and one multiple well site (Offset Well Test Facility). Analysis of this data and integration of the analyses with data obtained from previous Eastern Gas Shales Project research activities will provide a more comprehensive understanding of the overall reservoir producing mechanism for a greater segment of the total Devonian Shale resource base. Reservoir models developed from these data will provide a more accurate methodology for predicting shale well production performance for each of the target areas. Results to date are discussed. 2 references, 3 figures.

31441 (DOE/METC—86/6034, pp 63-64) **Overview: coalbed methane.** Byrer, C.W. (Dept. of Energy, Morgantown, WV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

Coalbed methane research is focused on methods to estimate the extent of the coalbed methane resource and its recoverable reserves with increased accuracy and reliability. The ultimate purpose is to encourage extensive private sector extraction of coalbed methane to assist in meeting national energy needs. A broad-based effort has been conducted in geological resource engineering, methane production model development, and basic research and development. A transition from the resource data gathering stage to an initial focus on diagnostic and model development effort is being made to permit refined predictive capabilities in methane reservoir estimates. The Department of Energy (DOE) has maintained a coordinated program with the Gas Research Institute (GRI) in the study of coalbed methane. GRI is emphasizing the production testing/production potential of the current and required technology for coalbed methane recovery. DOE continues its effort with resource, reserve, and reservoir predictability and performance.

31442 (DOE/METC—86/6034, pp 73-88) **Evaluation of the effect of methane adsorption/desorption in well tests on coal beds.** Reznik, A.A.; Bayles, G.A. (Univ. of Pittsburgh, PA). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AH21-85MC03193.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The methane in coal beds exists as both a free-phase and as an adsorbed phase on the coal matrix. Generally, the free- and adsorbed-gas phases coexist with in-situ water. At any instant it is only the free-phase which imparts pressure. Superimposed on this flowing system is the mass of gas which is desorbed or adsorbed as the free gas pressure decreases or increases, respectively. The transport of the matrix gas to or from the free gas interferes with the expected (i.e., conventional) pressure response at the wellbore. This pressure transient data would appear to yield erroneous interpretations as regards reservoir characteristics if such is related to solutions of the radial diffusivity equation (RDE) which are not modified by inclusion of an adsorption/desorption term. Modification f the RDE to incorporate an adsorption/desorption term and subsequent solutions of the RDE provide the primary object of the present work. The investigators to follow the performance of the gas phase in what is generally a methane and water producing well. 7 references, 6 figures, 1 table.

31443 (DOE/METC—86/6034, pp 89-90) **Measurement of dynamic reservoir conditions.** Boyer, C.M. II. (Steel Corp., Monroeville, PA). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC21-82MC19404.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

US Steel Corporation, the US Department of Energy, and the Gas Research Institute jointly installed and tested a single-zone coalbed methane well in the Warrior Coal Basin of Alabama. The well was installed into the Mary Lee Coal Group at US Steel's Oak Grove Mine near Birmingham, Alabama. Static reservoir tests were performed to determine the reservoir properties of the target coal seam and the surrounding rock formations. Dynamic reservoir tests prior to hydraulic stimulation were also performed to further delineate the reservoir conditions. These tests results were incorporated

in the design and implementation of a large-scale gelled water stimulation of the target coal seam. Additional dynamic reservoir tests were performed following the stimulation to determine the effectiveness of treatment. Following completion of the stimulated production testing, the coal was mined-out in the wellbore area and direct observation and evaluation of the induced hydraulic fracture was made. 1 reference.

31444 (DOE/METC—86/6034, pp 91-98) **Coalbed methane stimulation analysis.** Layne, A.W. (Morgantown Energy Technology Center, WV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The coalbed methane stimulation analysis included an evaluation of mine excavation data to determine stimulation results, Nolte analysis to characterize fracture behavior, and stimulation modeling efforts. The Nolte analysis provides a method to characterize induced hydraulic fracture behavior with a plot of fracture pressure versus treatment time. Characterization of the fracture behavior is determined by the slope of the pressure-time plot. METC's hydraulic fracture models were used to predict the DHM-6 and DHM-7 induced fracture geometries. The models included OSUFRAC, a generalized hydraulic fracture model, TUFRAC, proppant transport model, ORUFRAC, a height growth model, and FEFFLAP, a hydraulic fracture model for jointed rock. The DHM-6 and DHM-7 formation properties and treatment schedules were used in the modeling efforts. Results of the analysis provide a basis for determining the applicability of METC hydraulic fracture models and the Nolte analysis to coal seam stimulation. 8 references, 7 figures, 2 tables.

31445 (DOE/METC—86/6034, pp 99-107) **Coalbed methane geostatistical analysis project.** Mercer, J.C. (Morgantown Energy Technology Center, WV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The purpose of coalbed methane geostatistical study was to identify correlations between geologic parameters and gas production for wells completed in the Oak Grove (US Steel) field in Alabama. The study area consisted of 23 wells in the primary degasification grid and 15 wells adjacent to the grid. The primary data analysis was performed utilizing multivariate statistical procedures. The intent of the analysis was to provide information on the effects of various geologic and lineament variables on gas production. It was also intended that the variables having the most significant effect on production be identified and used for predicting production. Results are discussed. 6 figures, 1 table.

31446 (DOE/METC—86/6034, pp 108-110) **Overview: western gas sands.** Frohne, K.H. (Dept. of Energy, Morgantown, WV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

Western Gas Sands research is a multidisciplinary effort supporting the development of low-permeability tight gas sands in the western US. Its purpose is to determine the feasibility of economically producing natural gas from lenticular sand reservoirs. The approach for realizing this purpose consists of conducting research as well as encouraging industrial efforts in developing the necessary technology. In order to accomplish this, two broad objectives were defined: (1) to reduce the uncertainty of the reservoir production potential through an increased understanding of the resource, and (2) to improve the extraction technology so industry can develop the resource. In pursuit of these objectives, the following approach to western gas sands research was developed: (1) resource definition and development of reserves through geologic research and integration for the priority basins; (2) supporting generic research on reservoir properties and performance, geomechanics research, and the development of a predictive capability in reservoir analysis and stimulation design and performance evaluation; and (3) development of reservoir evaluation and extraction technologies through production research in well-characterized and fully instrumented field laboratory settings - Multiwell Experiment (MWX) and Nevada Test Site (NTS). Current activities are briefly described.

31447 (DOE/METC—86/6034, pp 163-173) **LLNL unconventional gas/western sands research.** Heuze, F.E.; Lin, W.; Shaffer, R.J.; Stout, R.B.; Wijesinghe, A.M. (Lawrence Livermore National Lab., CA). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract W-7405-ENG-48.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of the LLNL Western Gas Sands (WGS) subprogram is to improve the understanding of the stimulation mechanics of lenticular and jointed tight gas reservoirs. Particular emphasis is put on the interaction of induced fractures with natural fractures, and on the determination of relevant rock mass properties for input in hydrofracture simulators. The main thrust is the development and verification of computer models to analyze hydrofracturing in complex rock formations. The first versions of two such computer codes were completed and documented in FY 1985. The testing and analysis of western reservoir rock material properties also have been obtained by different methods. Results are presented. 19 references, 8 figures, 2 tables.

31448 (DOE/METC—86/6034, pp 174-184) **Stimulation model for lenticular sands.** Rybicki, E.F.; Palmer, I.; Sutrick, J.S.; Luiskutty, C.T.; Tomutsa, L. (Univ. of Tulsa, OK). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC21-84MC21119.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of this project is two-fold. One objective is to develop a computational model to represent hydraulic fracturing and proppant transport for lenticular sands in tight western gas sands formations. The other objective is to apply this model to the multi-well experimental fracture stimulations. The approach to meeting the first objective, the development of the computational model for hydraulic fracturing and proppant transport, is to develop the capabilities of two existing models and combine these models into a single representative model. One computational model is the fracture geometry model developed at Oral Roberts University (ORU) and National Institute for Petroleum Energy Research (NIPER). The other model is a proppant transport model developed at The University of Tulsa (TU). The plan for combining these models is to utilize the NIPER/ORU model for fracture length, width and height calculations and the TU model for proppant pumping, transport and final distribution. Each year of the three year program corresponds to one phase of the effort. The following describes the development of the fracture model and the proppant transport model and the progress toward combining these two models. 17 references, 5 figures, 4 tables.

31449 (DOE/METC—86/6034, pp 194-206) **Western gas sands systems analysis.** Mercer, J.C. (Morgantown Energy Technology Center, WV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

Researchers at the Department of Energy's (DOE) Morgantown Energy Technology Center (METC) are providing technical support to the Western Gas Sands Program. This support focuses on reservoir engineering, computer modeling, and geologic data interpretation. The primary activities are (a) an ongoing analysis of reservoir and stimulation data from the Multiwell Experiment (MWX), and (b) a gas migration study to quantify potential gas loss from Naval Oil Shale Reserve (NOSR) No. 3 to producing commercial wells in the Rulison Field. In the MWX data analysis portion of the study, the effects of both a minifracture stimulation and a full-scale stimulation of Zones 3 and 4 of the Paludal Sandstone Interval at the MWX site were assessed. Also, the Red and Yellow Zones of the Coastal Interval were characterized using reservoir simulation history-matching techniques. In the NOSR No. 3 portion of the study, a reservoir simulation and an engineering analysis were conducted for two tight lenticular sandstone units, the Wasatch Formation and the lenticular portion of the Mesaverde

Group, in Garfield County, Colorado. The study quantified potential gas loss through migration from the NOSR No. 3 to nearby producing wells located in the Rulison Field, and forecasted production for proposed NOSR No. 3 wells located at previously selected sites, off-setting commercial wells outside the reserve. 7 figures, 4 tables.

31450 (DOE/METC—86/6034, pp 207-214) **Development of the resource extraction data base to support the eastern gas shales, western gas sands, and coalbed methane programs.** Yost, A.B.; Frohn, K.H.; Byrer, C.W. (Morgantown Energy Technology Center, WV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of the Resource Extraction Data Base (REDB) is to provide a source of accurate Eastern Gas Shale (EGS), Coal Bed Methane (CBM), and Western Gas Sands (WGS) information. The data base is the principal gathering point for relevant research information for the DOE unconventional gas recovery programs. It includes documented information from other sources as well. The REDB is designed to contain geologic, economic, and production data related to oil and gas wells. The information contained in the data base is based primarily on the Well History Control System as provided by the Petroleum Institute (PI). The system has been designed to handle EGS, CBM, and WGS data simultaneously and utilizes the Statistical Analysis System (SAS) to provide a menu-driven system to the user. Because the sources of project specific information and the data users are generally the same for the EGS, CBM, and WGS data, a single data base format and structure was selected for use. All unconventional gas recovery data will be entered into the METC Resource Extraction Data Base (REDB) to allow for more rapid access to the data of interest and to effectively utilize computer storage of the rather voluminous unconventional gas recovery data.

31451 (DOE/METC—86/6034, pp 215-219) **Mineback stimulation research experiments.** Warpinski, N.R. (Sandia National Labs., Albuquerque, NM). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC04-76DP00789.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of the Mineback Stimulation Research Experiments is to improve hydraulic fracture stimulation technology by providing an in situ laboratory where basic processes and mechanisms that control and influence fracture propagation can be observed, measured and understood. While previous tests have been instrumental in providing an understanding of the mechanisms controlling fracture height, current experiments are focused on fluid flow through the created fracture and the associated pressure drops and crack widths. Results are briefly discussed. 7 references, 2 figures.

31452 (DOE/METC—86/6034, pp 220-224) **High energy gas fracture research.** Cuderman, D.A. (Sandia National Labs., Albuquerque, NM). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC04-76DP00789.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of high energy gas fracture (HEGF) research is to develop fracture techniques for application in gas well stimulation. This is done using propellants whose burn rates can be tailored for specific applications. Previous research successfully developed technology for multiple fracturing liquid-free, uncased wellbores and applied it to gas wells in Devonian shale. Current efforts are directed toward developing HEFG for stimulating wells which are cased and perforated, both with and without liquid present. The project and results are described. 5 references.

31453 (DOE/METC—86/6034, pp 225-231) **Multiwell experiment.** Sattler, A.R.; Warpinski, N.R.; Lorenz, J.C.; Hart, C.M.; Branagan, P.T. (Sandia National Labs., Albuquerque, NM). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC04-76DP00789.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The Multiwell Experiment is a research-oriented field laboratory. Its overall objectives are to characterize lenticular, low-permeability gas reservoirs and to develop technology for their production. Its wide range of activities and its wealth of data are providing a unique, in-depth look at a significant natural gas resource in the western US. A description of the project is given and results of the past year's work are listed. 4 references.

31454 (DOE/METC—86/6034, pp 232-238) **Multiwell fracturing experiments.** Warpinski, N. (Sandia National Labs., Albuquerque, NM). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC04-76DP00789.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of the Multiwell fracturing experiments is to test and develop the technology for the efficient stimulation of tight, lenticular gas sands. This requires basic understanding of (1) fracture behavior and geometry in this complex lithologic environment, and (2) subsequent production into the created fracture. The intricate interplay of the hydraulic fracture with the lens geometry, the internal reservoir characteristics (fractures, reservoir breaks, etc.), the in situ stresses, and the mechanical defects (fractures, bedding, etc.) need to be defined in order to develop a successful stimulation program. Results to date are presented. 5 references, 2 figures, 2 tables.

31455 (DOE/METC—86/6034, pp 239-243) **Multiwell experiment: fracture diagnostics.** Hart, C.M. (Sandia National Labs., Albuquerque, NM). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—). Contract AC04-76DP00789.

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The objective of the fracture diagnostics program is to develop and demonstrate an integrated instrumentation system for measuring hydraulic fracture geometry. The principal product of this development program will be a set of interlinked instrumentation systems which, collectively, provides information regarding fracture orientation, length, height, and width. The Multiwell Experimental provides the medium for demonstration of the developing technology. The four subsystems of the instrumentation system, which will be linked together by a microcomputer network, include (1) an internal-fracture-pressure measurement system, (2) a fluid-flow measurement system, (3) a borehole seismic system, and (4) a surface electric potential measurement system. 5 references.

31456 (DOE/METC—86/6034, pp 244-253) **MWX reservoir engineering.** Branagan, P.; Cipolla, C.; Lee, S.J.; Wilmer, R. (CER Corp., Las Vegas, NV). Jan 1986. NTIS, PC A12/MF A01. File Number DE86001033. (CONF-8511111—).

From Unconventional gas recovery contractors' meeting; Morgantown, WV, USA (18 Nov 1985).

The reservoir engineering portion of the Multiwell experiment involves the design, implementation and analysis of various well and reservoir tests that has the following principle objectives: (1) develop a thorough description of the unstimulated Coastal Red and Yellow reservoirs; (2) assess the in situ production capacity of the natural fractures; (3) predict the effects that various stimulations will have on the principle production mechanisms; (4) assess and describe variations in production from field testing following fracturing experiments; and (5) integrate all test data to derive an analytic approach to production optimization. In order to achieve these objectives and the primary goals of the MWX project, a preliminary set of well tests and a variety of stimulation experiments are cooperatively proposed, evaluated and scheduled. These experiments are then performed at the MWX site in a serial fashion and

the results of each portion of testing provide valuable data or feedback from which to assess, and if necessary, modify future scheduled testing and experiments. This is the natural genesis of all experimental endeavors and has been effectively utilized at MWX. 2 references, 7 figures.

31457 **(PB—86-156148/XAB) Exploratory studies on deep earth sources of methane: Hg as a diagnostic and prospecting tool. Annual report, April-September 1985. Report No. 2.** Reed, G.W.; Jovanovic, S. (Argonne National Lab., IL (USA)). 3 Oct 1985. 18p. NTIS, PC A02/MF A01.

The report attempts to establish whether primordial volatiles are presently being vented to the surface of the earth. The objective is to examine the proposition that the mantle is a major repository for juvenile (abiotic) methane. The author seeks to complement data on excess ^{3}He, the only volatile generally accepted as being of mantle origin. The gases (fluids) that serve as carriers for ^{3}He might also be expected to transport volcanogenic trace volatiles such as Hg, Br, As, Sb, Se, Zn and Cu. These elements, representing a range of volatilities and geochemistries, are being measured in tholeiitic glass (quenched lavas) samples from different ocean ridge and ocean island mantle sources, for which ^{3}He data are available. A number of possibly significant concentration trends and interelement correlations are observed. As examples, tholeiitic magmas from diverse sources contain unfractionated Hg and Sb and covariant Zn and Cu (the latter pair relative to cosmic abundance). A primitive source is inferred for all the volatiles and their interrelation may complement the ^{3}He mantle signature. Preliminary data on Hg associated with hydrocarbon-containing igneous rock formations appear to support the thesis that Hg may accompany hydrocarbons from non-biogenic sources and thus may be used for prospecting.

31458 **(PB—86-156189/XAB) Measuring formation pressures and the degree of gas drainage in a large coalbed gas-drainage field. Report of Investigations/1985.** Oyler, D.C.; Stubbs, P.B. (Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center). 1985. 22p. (BM-RI—8986). NTIS, PC A02/MF A01.

The Bureau of Mines and United States Steel Corp. are conducting a joint project to monitor formation pressures at a large (23-well) coalbed gas drainage field near Oak Grove, AL. Three monitor holes were drilled in late 1981, and pressure monitoring began in December 1981. The Bureau of Mines direct method was used to obtain gas content data from cores taken in the monitor holes. Comparison of the 1981 gas content data from the monitor holes with initial gas content values obtained from the production wells in 1977 indicates a 50% reduction in adsorbed gas content inside the pattern and a 29% reduction at one point 500 ft outside the pattern.

31459 **An improved model for fluid-driven cracks in jointed rock.** Shaffer, R.J.; Ingraffea, A.R.; Heuze, F.E. (Lawrence Livermore National Lab., CA). pp 333-340 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—). Contract W-7405-ENG-48.

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

The finite element model FEFFLAP (Finite Element Fracture and Flow Analysis Program) is being developed for and applied to hydrofracture analyses in support of the Unconventional Gas Recovery Program at the Lawrence Livermore National Laboratory. The major characteristics of FEFFLAP were presented earlier. Two improvements made to the model are presented here: a multiple load capability and a selection of minimum aperture for fluid flow. The results of two verification and example problems are also given.

0310 Legislation And Regulation

31460 **(DOE/NBM—6010458) Analysis of the Department of Energy's Notice of Proposed Rulemaking (NOPR), "ceiling prices: old gas pricing structure".** (USDOE Energy Information Administration, Washington, DC. Office of Oil and Gas). May 1986. 170p. (RNGD—86-03). NTIS, PC A08/MF A01; 1 - GPO; GPO Dep. File Number DE86010458.

On November 25, 1985, the Department of Energy (DOE) issued a Notice of Proposed Rulemaking (NOPR), "Ceiling Prices: Old Gas Pricing Structure." The proposal seeks to eliminate vintaging and to raise ceiling prices for old interstate gas regulated under the Natural Gas Policy Act (NGPA) Sections 104 and 106(a), and to establish incentive price ceilings for three new categories of high-cost, interstate and intrastate gas. This report was prepared by the Energy Information Administration, at the request of Congressman John D. Dingell, Chairman of the House Committee on Energy and Commerce. The work was done by the Office of Oil and Gas under the directorship of Jimmie L. Petersen. Major contributors were Richard P. O'Neill, regulatory history; John Wood, James Hicks, Hafeezer Rahman, William Dietzman, Charles Jirik, Jack Sanders, additional gas recovery methods; and W. David Montgomery, John Pearson, price impacts. 12 figs., 10 tabs.

31461 **(NRRI—86-5) Economic analysis of block billing for natural gas.** Henderson, J.S. (National Regulatory Research Inst., Columbus, OH (USA)). Mar 1986. 48p. NRRI, 1080 Carmack Road, Columbus, OH 43210. File Number TI86901365.

As part of its Final Order 436 the Federal Energy Regulatory Commission (FERC) issued a Notice Requesting Supplemental Comments on Part D of RM 85-1-000 that would establish a block-drilling mechanism for jurisdictional sales of natural gas interstate pipeline companies. Under the proposal, pipelines would divide each customer's bill into two parts, or blocks. Block 1 would consist mostly of the cost of old, price regulated gas, while block 2 would consist of all other categories of gas. Each pipeline customer would be given a fractional allocation of the pipeline's annual block 1 sales. This report highlights the substantive economic arguments for and against block billing. The first section gives an overview of the block-building proposal, after which a more detailed discussion of particular issues is presented. The intent is to examine the consequences of block billing from the perspective of both the eventual, long-run market equilibrium, and the dynamic adjustment process of reaching such an equilibrium. 3 figs., 2 tabs.

0320 Transport, Pipelines, And Handling

REFER ALSO TO CITATION(S) 32867

31462 **New pipe steel test gets critical study.** Williams, D.N. (Battelle Columbus Labs., Richland, WA). *Oil and Gas Journal;* **79**: 86-90, 95-96(2 Mar 1981).

The increasing demand for transmission pipelines capable of carrying sour gas has created considerable interest in test procedures for measuring the resistance of pipe steels to hydrogen blistering and hydrogen-induced stepwise cracking in environments containing hydrogen sulfide. Consequently, Battelle developed a simple test to evaluate pipe-steel resistance to stepwise cracking in the presence of hydrogen sulfide. The eight steels examined responded quite differently to the test; each steel's cracking resistance seemed to correlate somewhat with its composition and microstructural features. The results of duplicate tests on the same steels, however, showed considerable variation, and the assessment of the steels' relative resistance to stepwise cracking was questionable. To be reliable for selecting steels for service in hydrogen sulfide-containing environments or for designing improved steels for such service, the test procedure needs further development.

31463 **Overview of plastic pipe research at Battelle.** Epstein, M.M. (Battelle Columbus Labs., OH). *American Gas Association, Operating Section, Proceedings;* D204-D208(1980).

Battelle is currently conducting 10 research projects related to plastic pipe in gas-distribution applications; the most comprehensive program is sponsored by Gas Research Institute. the basic goals are to (1) understand the aging processes in plastic piping materials, (2) develop methods for predicting long-term performance, (3) define the relationships among composition, structure, and performance, and (4) determine the influence of field practices (including storage and joining) on performance. In addition, Battelle is improving failure experiment designs and data-interpretation methods.

0330 Properties

REFER ALSO TO CITATION(S) 31419

31464 **(PB—86-155983/XAB) Analyses of natural gases, 1984. Information Circular/1985.** Moore, B.J.; Hamak, J.E. (Bureau of Mines, Amarillo, TX (USA). Helium Field Operations). 1985. 108p. (BM-IC—9046). NTIS, PC A06/MF A01.

The Bureau of Mines publication contains analyses and related source data for 276 natural gas samples from 23 States. All samples except four were collected during calendar year 1984. Those four samples were collected earlier, but releases granting permission to publish were not received until 1984. All samples were obtained and analyzed as part of Bureau of Mines investigations of the occurrences of helium in natural gases of countries with free-market economies. The survey has been conducted since 1917. The analyses published herein were made by the mass spectrometer and chromatograph. The results of these investigations are published annually to make the information available to the petroleum industry and the general public. In 1976, a compilation of the analyses made prior to 1975 was prepared by the Bureau of Mines and published by the National Technical Information Service of the U.S. Department of Commerce. In addition to being in the publications, all analyses and related information published through 1984 are available on a magnetic tape file.

0340 Combustion

REFER ALSO TO CITATION(S) 31751, 31754, 32074, 32109, 32517

0350 Storage

REFER ALSO TO CITATION(S) 31415

04 OIL SHALES AND TAR SANDS

0401 Reserves And Exploration

31465 **(DOE/LC/11061—T6) DOE Oil Shale Reference Sample Bank. Quarterly reports, October-December 1985; January-March 1986.** Owen, L.B. (Terra Tek, Inc., Salt Lake City, UT (USA)). Apr 1986. Contract AC20-85LC11061. 64p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86009294.

Two FY-86 reference shales have been acquired, processed and stored under inert gas. The Eastern shale, designated E86, was obtained from the Clegg Creek Member of the New Albany Shale at a quarry near Louisville, Kentucky in the first quarter of FY86. The western shale was obtained from the Exxon Colony Mine, located near Parachute, Colorado, during the second quarter of FY 86. Partial distributions of both shales have been made to DOE contractors. Complete descriptions of the reference shale locales, shale processing procedures and analytical characterization are provided in the following sections of this report. 26 tabs.

0404 Oil Production, Recovery, And Refining

REFER ALSO TO CITATION(S) 32359

31466 **(SAND—85-2749C) Uniform retorting of an anisotropic shale bed.** Bickel, T.C.; Cook, D.W.; Engler, B.P. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 13p. (CONF-8604172—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010098.

From 19. annual oil shale symposium; Golden, CO, USA (21 Apr 1986).

In situ oil shale retorts have typically been designed for the fracturing event to produce a rubble bed having uniform cross-sectional rubble properties. This uniform rubble bed approach strived to produce constant void fraction and particle size distribution within all regions of the rubble bed. Ideally, these isotropic rubble beds have uniform flow of oxidants, retorting and combustion products. However, edge effects during the blast event typically produce channeling at the retort walls during processing, reducing the rubble sweep and the local yield. Second generation in situ retorts are addressing uniform retorting within the rubble bed rather than the uniformity of rubble bed properties. Here, the blast design produces and anisotropic rubble bed with varying particle size distribution and void fraction normal to the direction of flow. This paper describes a laboratory experiment in which a highly-instrumented, 100 kg bed of shale with zones of differing particle size and void was retorted. Shale particle size and void were varied over the retort cross-section so that a retorting front would move at a constant velocity downward through the rubble bed. The bed was designed using data from numerous pressure drop measurements on uniform shale beds of varying shale particle size distribution and void. Retorting of the bed showed a uniform retorting front and a yield comparable with that achieved in isotropic shale beds. We present thermal data and offgas, oil and shale analyses (allowing material and energy balance closures) and compare these data to previous vertical retorting experiments on uniform and non-uniform beds of shale. This experiment verifies that uniform retorting fronts can be achieved in correctly designed anisotropic beds of shale and validates the concept of uniform retorting in order increase the oil recovery in second generation retorts. 20 refs., 17 figs., 4 tabs.

31467 **International developments in oil shale.** Uthus, D.B. (Dept. of Energy, Washington, DC). *Energy Technology (Washington, D.C.);* **12**: 1274-1294(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

An overview of oil shale research and development outside the US provides a status report on technology approaches under active consideration in Australia, Brazil, Canada, China, West Germany, Israel, Jordan, Morocco, Soviet Union, Thailand, Turkey, and Yugoslavia. The status report covers the development plans and project costs of industrial projects. The technologies under consideration include the Fushun, Galoter, Kiviter, Lurgi, and Petrosix processes. 10 references.

31468 **The effect of retorting pressure on oil yield and rate of oil generation from oil shale.** Sohn, H.Y.; Yang, H.S. New York, NY; American Institute of Chemical Engineers (1985). 32p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AS03-78ET13095.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

The effect of pressure ranging from 0.05 to 0.86 atm on oil yield and retorting rate was determined under various retorting conditions. As pressure decreased, both oil yield and retorting rate increased substantially. The experimental data analysis was based on a mathematical model.

31469 **Gas evolution during oil shale pyrolysis. Part 1. Nonisothermal rate measurements.** Campbell, J.H.; Koskinas, G.J.; Gallegos, G.; Gregg, M. (Lawrence Livermore Lab., CA). *Fuel;* 59: 718-726(Oct 1980).

The rate of release of CH_4, H_2, CO_2, CO, and both C_2 and C_3 hydrocarbons during the pyrolysis of Colorado oil shale between 77° and 1650°F at 1 atm was measured. Slow heating rates, ranging from 0.9° to 7.2°F min, were used to simulate possible combustion retorting of oil shale in either underground or surface retorts. Hydrogen was the major condensable gas produced by the kerogen pyrolyses. The amount of H_2 released was influenced, via the shift and Boudouard reactions, by the CO_2 evolved from the mineral carbonates. Lesser amounts of C_1, C_2, and C_3 hydrocarbons were produced. On the basis of heat content, however, the combined C_1-C_3 hydrocarbons contributed twice as much as H_2 to the heating value of the pyrolysis gas. The evolution of H_2 and CH_4 involved processes that were interpreted as a primary pyrolysis of the kerogen to generate oil and a higher temperature secondary pyrolysis of the carbonaceous residue. The CO formed was a product of the Boudouard reaction; a nearly complete conversion of the carbon residue to CO via this reaction was observed.

0408 Marketing And Economics

REFER ALSO TO CITATION(S) 31467

0409 Waste Research And Management

31470 **Effect of ozonation and UV irradiation on biorefractory organic solutes in oil shale retort water.** Daughton, C.G.; Healy, J.B.; Jones, B.M.; Langlois, G.W.; Sakaji, R.H. New York, NY; American Institute of Chemical Engineers (1985). 26p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC03-76SF00098.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Biooxidation of oil shale process wastewaters in dispersed-phase cultures removed only 9-50% of the dissolved organic carbon. Attempts to promote biodegradation of the refractory carbon (predominantly aromatic amines) by physicochemical means met with little success. These included ultraviolet irradiation/ozonation, addition of activated carbon to dispersed-phase cultures, and use of fixed-film bioreactors.

0410 Environmental Aspects

REFER ALSO TO CITATION(S) 31413, 32859

05 NUCLEAR FUELS

0501 Reserves

31471 **(IPEN-Pub—69) Mapping Brazilian radioactive minerals by gamma-ray spectrometry and using a germanium detector.** Pereira, W.; Atalla, L.T.; Abrao, A. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 131p. (In Portuguese). NTIS (US Sales Only), PC A07/MF A01. File Number DE86702016.

This paper has as scope the organization of a catalogue of the main uranium and/or thorium minerals using their gamma-ray spectra registered by their natural radioactivity with a pure germanium detector. The objective is to accumulate data for the radiometric identification for a posterior comparative study of minerals of the same procedence or from new uranium and thorium occurrences. On the respective spectra are marked the main peaks, their energies and the correspondent radioisotopes. An estimative of their radioactive equilibrium state is included. As additional information the decay of the descendents of the natural series of ^{235}U, ^{238}U and ^{232}Th, their gamma-ray energies and, finally, a table of the main uranium and thorium ores are presented.

0502 Exploration

REFER ALSO TO CITATION(S) 32604

31472 **R-mode factor analysis applied to uranium exploration in the Montrose quadrangle, Colorado.** Bolivar, S.L.; Campbell, K.; Wecksung, G.W. (Los Alamos National Lab., NM, USA). *Journal of Geochemical Exploration;* 19: No. 1-3, 723-743(1983). (CONF-8205314—).

From 9. international geochemical exploration symposium; Saskatoon, Canada (12 May 1982).

R-mode factor analysis is used to describe the relationships among 18 remotely sensed and geochemical data sets (variables) for the Montrose 1° x 2° quadrangle, Colorado, a region that covers 19,000 km^2. The data sets contain reconnaissance-scale information and include Landsat imagery, airborne geophysical information (eU, eTh, K40, aeromagnetics), elevation, and hydrogeochemical and stream sediment analyses. The elements U, K, Dy, Hf, V, Th, Ca and Ba in sediments and U in waters were selected. The results of the factor analysis for the entire quadrangle are compared to the results for a 50 km x 50 km test area containing several known uranium occurrences. Four factors account for 70.0% of the total variance in the data. These are interpreted as a felsic factor, Landsat factor, economic or mineralization factor (in terms of uranium mineralization and potential mineralized areas), and a volcanic factor. Graphical representations (maps) of the raw data, factor approximations, residuals for each data set and the four-factor model greatly aid interpretation of the analytic results. It is found that data integration techniques and R-mode factor analysis can be used with some success in uranium resource appraisal.

0504 Feed Processing

31473 **(MINTEK-M—204) Selection of a matrix for the recovery of uranium by wet high-intensity magnetic separation.** Svoboda, J. (Council for Mineral Technology, Randburg (South Africa)). 30 May 1985. 29p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702007.

The proper choice of a suitable matrix for high-intensity magnetic separation is of the utmost importance, since the geometry and size of the matrix play decisive roles in the achievement of optimum separation conditions. In relatively simple filtration applications, the matrix must offer a high efficiency of collision with suspended particles, a high probability of retention of intercepted particles, and high loading capacity. Also, it must be easily cleaned. The results obtained by the use of theoretical models of magnetic separation fail to agree with the experimental results for basic parameters like the ratio of particle size to matrix size, the length of the matrix, and the magnetic properties of the matrix material. Preconceived ideas about the matrix often lead to the erroneous choice of a matrix, and hence to its unsatisfactory performance during magnetic separation. The potential value of high-intensity magnetic separation as applied to the recovery of uranium and gold from leach residues and in association with the development of a large-scale magnetic separator to be used for the same purpose led to the present investigation in which a wide spectrum of matrix shapes and sizes were tested. It was found that the optimum recovery and selectivity of separation are obtained at a ratio of particle size to matrix-element size ranging from 200 to 300. The use of these matrices also results in a low degree of mechanical entrapment, particularly of coarser particles, for which straining plays a significant role for fine matrices. It was also found that the magnetization of a matrix plays a minor role, contrary to the theoretical predictions. Furthermore, the effects of matrix height, matrix loading, and scalping of the pulp by paramagnetic matrices were evaluated for various types of matrices.

0505 Enrichment

REFER ALSO TO CITATION(S) 31861

31474 **(ENEA-RT/FIMA—82-3) Numerical analysis of the thermally induced flow in a strongly rotating gas centrifuge.** Novelli, P. (ENEA, Casaccia (Italy). Dipartimento Ciclo del Combustibile). Apr 1982. 99p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86901369.

The present work is concerned with the numerical analysis of the thermally induced flow in a rapidly gas centrifuge. The primary purpose for this work is to investigate the dependence of the flow field on the thermal boundary conditions, angular speed, aspect ratio of the cylinder, holdup. Some of our results are compared with the predictions of asymptotic theories, particularly those of Sakurai-Mtsuda and Brouwers, and with the numerical results of Dickinson-Jones.

0506 By-products

REFER ALSO TO CITATION(S) 31546

0507 Fuels Production And Properties

REFER ALSO TO CITATION(S) 31886

31475 (IAEA-TECDOC—352, pp 163) **Direct pressing: A new method of fabricating MX fuel pellets.** Richter, K.; Kramer, G.; Sari, C.; Werner, P. (Commission of the European Communities, Karlsruhe, Germany, F.R. European Inst. for Transuranium Elements). Oct 1985. NTIS (US Sales Only), PC A11/MF A01. File Number DE86780461. (CONF-8412103—).

From Advisory group meeting on advanced fuel technology and performance; Wuerenlingen, Switzerland (4 Dec 1984).

31476 **(IAEA-TECDOC—352) Advanced fuel technology and performance. Proceedings of an advisory group meeting held in Wuerenlingen, Switzerland 4-6 December 1984.** (International Atomic Energy Agency, Vienna (Austria)). Oct 1985. 246p. (CONF-8412103—). NTIS (US Sales Only), PC A11/MF A01. File Number DE86780461.

From Advisory group meeting on advanced fuel technology and performance; Wuerenlingen, Switzerland (4 Dec 1984).

Individual papers were processed.

31477 (INIS-BR—462, pp 113-116) **Study of the solid solution formation in mixed oxides by X-ray diffraction.** Riella, H.G. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

A method to determine the plutonium distribution in mixed oxides - UO_2/PuO_2 is described. The distribution function and the medium size of crystallite are obtained from the X-ray diffraction profile. Through the deconvolution by Fourier analysis, the X-ray diffraction profile is obtained without the influence of the diffractrometer. Some experimental results for different samples of UO_2-PuO_2 is discussed.

0508 Spent Fuels Reprocessing

31478 **(AERE-G—3331) Liquid discharge to sea/rivers/lakes. The solubility of TBP/OK in aqueous media.** Drake, V.A. (UKAEA Atomic Energy Research Establishment, Harwell. Chemistry Div.). Sep 1985. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702008.

The solubility of tributyl phosphate/odourless kerosene (TBP/OK) in aqueous media has been investigated in order to provide information about the solubility of reprocessing plant solvent in liquid effluents and sea water. In an attempt to supplement sparse and often inconsistent data reported in the literature, an experimental programme to study the solubility of nominally 20% TBP/OK in solutions of pH 2 to 10 and in sea water for the temperature range 0 to 20°C was carried out. The solubility of the diluent (OK) alone was also studied in Analar and sea water solutions over a similar temperature range. A phosphorus-32 radioactive labelling technique was adopted as the initial method for measuring TBP solubility. Radiometric methods have been used extensively for the determination of slightly soluble compounds in liquid systems, and this was considered to be a potentially more convenient and accurate technique than either chemical or physical methods such as chromatography or spectroscopy. However, because of the apparently 'high' TBP solubilities obtained, repeat experiments using gas chromatography (G.C) analysis were subsequently carried out; this also enabled the solubility of the diluent OK to be simultaneously measured. The results obtained from both analytical techniques have been reported and compared.

31479 **(FRNC-TH—2239) Contribution to the modelization of liquid-liquid extraction systems. Application to metallic nitrate extraction by TBP in nitric medium.** Ly, J. (Paris-6 Univ., 75 (France)). Oct 1984. 226p. (In French). NTIS (US Sales Only), PC A11/MF A01. File Number DE86751776.

The validity of theoretical expression for activity coefficients, in concentrated aqueous solution, proposed by Mikulin-Stokes-Robinson and Ryazanov-Vdovenko is confirmed by numerous tests. This allows a better control of the reactivity of chemicals in the extraction system: nitric aqueous solution-TBP organic solution used in nuclear hydrometallurgy. A reliable methodology is proposed for the study of metal extraction mechanism. Application to palladium (II) evidences extracted species in the organic phase. Influence of degradation product from extractant radiolysis on the behavior of this metallic element is effected. 187 refs.

31480 **Rekindled interest in pyrometallurgical processing.** Burris, L. (Argonne National Lab., Argonne, IL 60439). *Chemical Engineering Progress;* **82**: No. 2, 35(Feb 1986).

The IFR with its integral, on-site fuel recycle revived a concept pioneered at EBR-II. The reactor concept has become very attractive due to the advances in metal fuel performance over the past 15 years and in the understanding of the safety of metal-fueled reactors. The proposed fuel cycle carries out Lawroski's call for development of a low-cost fuel cycle for fast reactors to help them become economically competitive. The IFR represents a new direction in breeder developments. The next two years will be devoted to establishing experimentally the chemical feasibility of the pyrometallurgical process. Once it becomes feasible, the EBR-II fuel cycle facility can be refurbished and the process using IFR-type fuel irradiated in EBR-II.

31481 **Testing and economical evaluation of U(IV) in Purex.** Hsu, Th.C.; Hoisington, J.E. (E. I. du Pont de Nemours & Co., Inc., Savannah River Laboratory, Aiken, SC). pp 305-311 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

The use of uranous nitrate, U(IV), as a plutonium reductant in the Purex solvent extraction process could significantly reduce the waste generation at the Savannah River Plant. The current reductant is a ferrous sulfamate (FS)/hydroxylamine nitrate (HAN) mixture. The iron and sulfate in the FS are major contributors to waste generation. The U(IV) reductant oxidizes to U(VI) producing no waste. The Savannah River Laboratory has developed an efficient electrochemical cell for U(IV) production and has demonstrated the effectiveness of U(IV) as a plutonium reductant. Plant tests and economic analyses are currently being conducted to determine the cost effectiveness of U(IV) implementation. The results of recent studies are presented.

0509 Transport And Storage

REFER ALSO TO CITATION(S) 31491, 32415, 32420, 32426, 33214

31482 (ANL/ER-TM—85-2) Preliminary assessment of costs and risks of transporting spent fuel by barge. Tobin, R.L.; Meshkov, N.K.; Jones, R.H. (Argonne National Lab., IL (USA)). Dec 1985. Contract W-31-109-ENG-38. 93p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010244.

The purpose of this study is to analyze the costs and risks associated with transporting spent fuel by barge. The barge movements would be made in combination with rail movements to transport spent fuel from plants to a repository. For the purpose of this analysis, three candidate repository sites are analyzed: Yucca Mountain, Nevada, Deaf Smith, Texas, and Hanford, Washington. This report complements a report prepared by Sandia National Laboratories in 1984 that analyzes the costs and risks of transporting spent fuel by rail and by truck to nine candidate repository sites.

31483 (DOE/RW/00037—T1) Assessment of the use of a multi-purpose and centralized facility for the disassembly and packaging of spent nuclear fuel to support the various segments of the DOE Waste Management System. (Johnson (E.R.) Associates, Inc., Reston, VA (USA)). Dec 1985. Contract AC01-84RW00037. 101p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86009654.

The objectives of this study were to examine the various considerations associated with the use of a multi-purpose and central disassembly and packaging facility to support the operation of Monitored Retrievable Storage (MRS) and repository facilities in a variety of host geologic formations and to assess the economic and operational viability of such a concept in the overall spent fuel management system. A further objective of the proposed effort was to determine the cost of a system incorporating a central disassembly and packaging facility in comparison with that of the reference repository system, under a variety of waste system assumptions. The reference repository system was taken to be one in which both disassembly and overpacking was performed at the site of each repository.

31484 (DOE/RW/00037—T1-App.) Assessment of the use of a multi-purpose and centralized facility for the disassembly and packaging of spent nuclear fuel to support the various segments of the DOE Waste Management System. Appendices. (Johnson (E.R.) Associates, Inc., Reston, VA (USA)). Dec 1985. Contract AC01-84RW00037. 333p. NTIS, PC A15/MF A01; GPO Dep. File Number DE86009655.

This volume contains the following appendices: Basic Study Assumptions; Break-Out of the Cost Components of the Reference Single Stage Salt Repository System into Repository and Packaging Facility Components; Design of Central Disassembly and Packaging Facility and Estimated Costs; Design of a Repository Cask Receiving and Handling Facility and Estimated Costs; Design of Spent Fuel and Waste Package Transport Casks and Estimated Costs of Transport; Design Criteria; Description and Estimated Costs for Monitored Retrievable Storage Facilities; and Estimated Costs of At-Reactor Storage.

31485 (INIS-mf—10093) Royal Decree 1749/1984 of 1 August approving the national regulations on the safe transport of dangerous goods by air together with technical instructions for the safe transport of dangerous goods by air. (International Atomic Energy Agency, Vienna (Austria)). 2 Oct 1984. 1p. (In Spanish). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702094.

Published in the Spanish Official Gazette.

This Royal Decree approves the national Regulations on the safe transport of dangerous goods by air. The Regulations as well as the attached detailed technical instructions are based on the 1981 revised text of the Annex concerning dangerous goods of the Chicago Convention on International Civil Aviation. It also covers radioactive materials.

31486 (INIS-mf—10124) 17 May 1985 - Ministerial Order made in implementation of Sections 3, 6 and 8 of the Royal Order of 5 November 1982 on training certificates for drivers of vehicles for road transport of hazardous materials in containers. (International Atomic Energy Agency, Vienna (Austria)). 11 Aug 1984. 2p. (In French and Dutch). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702095.

Published in Moniteur Belge.

This Order provides for procedures for extending the validity of training certificates for drivers of vehicles for road transport of hazardous materials, including radioactive materials, and for the approval of the different training departments by the competent authorities.

31487 (REG/G—CE-301-4) Standard format and content for the safety analysis report for onsite storage of spent fuel storage casks. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Apr 1986. 66p. U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. File Number TI86901190.

This draft regulatory guide supplies guidance for preparing the safety analysis report if the spent fuel storage installation is allocated with a civilian nuclear power reactor and spent fuel storage casks are used. (LHM)

31488 (REG/G—CE-306-4) Standard format and content for a topical safety analysis report for a dry spent fuel storage cask. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Apr 1986. 56p. US Nuclear Regulatory Commission, Washington, D.C. 20555. File Number TI86901189.

This draft regulatory guide provides guidance on the format and content of a Topical Safety Analysis Report (TSAR) for a spent fuel storage cask. There is no regulation that requires the submittal of a TSAR for spent fuel storage casks. However, is a specific cask were approved by the NRC for storage of spent fuel, the TSAR on that cask could be referenced other safety analyses. Applicants for license under Part 72 could use this information in their SAR. This would greatly reduce the cost and effort of developing an SAR. Casks used for storage of spent fuel on a reactor site could be those used for shipping spent fuel or could be those designed for storage only. Casks used for shipping must be licensed under 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," which requires stringent quality assurance and cask testing. Casks used for shipping or for storae only sould be approved by the NRC if their safety is demonstrated.

31489 (SAND—85-2715) Transportation impacts of the commercial radioactive waste management program. Cashwell, J.W.; Neuhauser, K.S.; Reardon, P.C.; McNair, G.W. (Sandia National Labs., Albuquerque, NM (USA); Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC04-76DP00789. 187p. (TTC—0633). NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86009929.

This report discusses the relative costs and national environmental impacts resulting from the transportation of spent nuclear fuel and high-level nuclear wastes to each of nine potential commercial repository sites. The analysis is an update of two previous studies performed for the Department of Energy and includes the Monitored Retrievable Storage (MRS) facility option as well as updated assumptions regarding high-level waste flows and transportation cask capacities. Comparisons among the repository sites indicate that the eastern-most repository sites have the lowest relative transportation costs and risks with the highest values calculated for the most western sites. Incorporation of an MRS into the system reduces the disparity between the costs and risks projected for the candidate site locations with the use of the large-capacity dedicated rail cask from the MRS showing a benefit for that scenario.

31490 **(SAND—85-7246) Spent fuel transportation in the United States: commercial spent fuel shipments through December 1984.** (Nuclear Assurance Corp., Norcross, GA (USA)). Apr 1986. Contract AC04-76DP00789. 17p. (TTC—0624). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010568.

This report has been prepared to provide updated transportation information on light water reactor (LWR) spent fuel in the United States. Historical data are presented on the quantities of spent fuel shipped from individual reactors on an annual basis and their shipping destinations. Specifically, a tabulation is provided for each present-fuel shipment that lists utility and plant of origin, destination and number of spent-fuel assemblies shipped. For all annual shipping campaigns between 1980 and 1984, the actual numbers of spent-fuel shipments are defined. The shipments are tabulated by year, and the mode of shipment and the casks utilized in shipment are included. The data consist of the current spent-fuel inventories at each of the operating reactors as of December 31, 1984. This report presents historical data on all commercial spent-fuel transportation shipments have occurred in the United States through December 31, 1984.

0510 Marketing And Economics

REFER ALSO TO CITATION(S) 31505, 31506

0520 Waste Management

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31491 **(AECL—8398) Canadian Nuclear Fuel Waste Management Program. Annual report, 1984.** McConnell, D.B. (comp.). (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Apr 1986. 113p. Worked performed under Canada/US Waste Management Information Exchange Agreement. File Number TI86901364.

This report is the sixth in the series of annual reports on the research and development program for the safe management and disposal of Canada's nuclear fuel waste. The report summarizes progress in 1984 for the following activities: storage and transportation of used fuel, immobilization of nuclear fuel waste, geotechnical research, environmental research, and environmental and safety assessment.

31492 **(AERE-G—3587) Assessment of the risk of embrittlement of a steel container by hydrogen picked up on the ocean bed.** Hardie, D. (UKAEA Atomic Energy Research Establishment, Harwell. Materials Development Div.). Sep 1985. 66p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86702013.

A realistic assessment of the likelihood of embrittlement of a plain carbon steel container for nuclear waste has been made by estimating the hydrogen levels that might be expected to develop in the steel as a consequence of the slow corrosion of the container and the possible effect that such a hydrogen concentration would have on its mechanical behaviour. By consideration of various possible models for the generation of hydrogen and its subsequent uptake into the steel or dissemination in the environment, it is concluded that the most pessimistic assessment of the concentration of hydrogen that could build up in the container walls during 1000 years burial would not significantly affect the resistance to failure of even relatively high strength steels.

31493 **(AERE-R—11636) Verification of NAMMU using HYDROCOIN.** Herbert, A. (UKAEA Atomic Energy Research Establishment, Harwell. Theoretical Physics Div.). Jan 1985. 29p. H.M. Stationery Office, London, price Pound 5.00.

The numerical accuracy of the finite-element groundwater flow code NAMMU has been verified using test case 2 of HYDROCOIN Level 1. This problem describes steady-state groundwater flow in a two-dimensional cross-section of hard rock, such as granite, intersected by fault zones of highly contrasting permeability. The hydraulic head distribution was found to be adequately modelled by a mesh of 310 quadratic elements. Furthermore, I have investigated means of determining local mesh deficiencies. No completely reliable quantitative measure was found, but local mass conservation measures are considered and found useful.

31494 **(AIF/NESP—035) Evaluation of the potential for de-regulated disposal of very low level wastes from nuclear power plants.** Chan, D.W.; Davis, J.P.; Danna, R.; Palmer, J.A.; Palmer, J.V.; Parrish, B.R.; Donovan, M.; Oztunali, O.I. (General Physics Corp., Columbia, MD (USA); Ebasco Services, Inc., New York (USA)). May 1986. 225p. Atomic Industrial Forum, Inc., 7101 Wisconsin Ave., Bethesda, MD 20814-4891. File Number TI86901394.

The purpose of this study is to review the characteristics of low-level waste streams generated in nuclear power facilities to determine which may be suitable for disposal by methods other than transfer to an NRC-licensed facility; and to evaluate the benefits, risks, and costs of exempting such very low level wastes from the disposal requirements of 10 CFR Parts 20 and 61. The conclusions of the study are as follows: The most important basic parameter for determining the dose to persons off-site due to disposal of wastes at a specific disposal site is the total activity of each isotope disposed of. There are several waste streams at nuclear power plants that have typical activity levels so low that they could be released for conventional disposal without undue risk to the public. Based on this study, PWR and BWR compacted trash appear to be the best candidates for generic de-regulation. Other PWR process streams may be promising candidates for case-by-case de-regulation, depending on their facility-specific characteristics and the point of de-regulation. Non-routine, high volume, low activity wastes, such as contaminated soil and sand-blasting sand, are excellent candidates for de-regulation. The savings in costs and licensed burial site space, coupled with the very low doses involved (which may indeed represent a net dose decrease rather than an increase), clearly justify permitting conventional disposal of VLW. Separation of VLW from wastes with higher levels of radioactivity is a simple process. If certain waste streams are de-regulated, plant radwaste operating and monitoring procedures may need adjustment to ensure and document that only exempt materials are being released from the licensee's control.

31495 **(BMI/ONWI—599) Feasibility study using hypothesis testing to demonstrate containment of radionuclides within waste packages.** Thomas, R.E. (Battelle Columbus Labs., OH (USA)). Apr 1986. Contract AC02-83CH10140. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010670.

The purpose of this report is to apply methods of statistical hypothesis testing to demonstrate the performance of containers of radioactive waste. The approach involves modeling the failure times of waste containers using Weibull distributions, making strong assumptions about the parameters. A specific objective is to apply methods of statistical hypothesis testing to determine the number of container tests that must be performed in order to control the probability of arriving at the wrong conclusions. An algorithm to determine the required number of containers to be tested with the acceptable number of failures is derived as a function of the distribution parameters, stated probabilities, and the desired waste containment life. Using a set of reference values for the input parameters, sample sizes of containers to be tested are calculated for demonstration purposes. These sample sizes are found to be excessively large, indicating that this hypothesis-testing framework does not provide a feasible approach for demonstrating satisfactory performance of waste packages for exceptionally long time periods.

31496 **(CONF-860695—2) Managing the Department of Energy's hazardous and mixed defense wastes.** Daly, G.H.; Sharples, F.E.; McBrayer, J.F. (USDOE Assistant Secretary for Defense Programs, Washington, DC. Office of Defense Waste and Transportation Management; Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010059.

From HazMat '86: hazardous materials management conference and exhibition; Atlantic City, NJ, USA (2 Jun 1986).

Like other large and complex industries, the nuclear weapons programs produce hazardous chemical wastes, many of which require special handling for the protection of health, safety, and the environment. This requires the interaction of a multiplicity of organizational entities. The HAZWRAP was established to provide centralized planning and technical support for DP RCRA- and CERCLA-related activities. The benefits of a centralized program integrator include DP-wide consistency in regulatory compliance, effective setting and execution of priorities, and development of optimal long-term waste management strategies for the DP complex.

31497 **(DOE/DP—0020) Evaluation of commercial repository capacity for the disposal of defense high-level waste.** Ettlinger, L.A.; Goldfarb, A.S.; Lord, N.W.; Price, B.H. (Mitre Corp., McLean, VA (USA). METREK Div.). Nov 1984. Contract AC01-83DP48017. 137p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86005422.

This report is organized as a comparison, criterion by criterion, of two basic options: separate defense waste and commercial waste repositories and one repository containing both defense and commercial waste. For each criterion, the critical question is whether some condition is discovered that would require the President to conclude that a separate defense waste repository is required. Based on the comparison presented in this report, the only factor that results in a significant advantage for either option is cost efficiency. A substantial cost advantage is to be gained by disposing of defense high-level wastes in repositories designed to accept both commercial and defense waste. The Department recommends this option be implemented.

31498 **(DOE/NE/44139—1) Analytical cell decontamination and shielding window refurbishment. Final report, March 1984-March 1985.** Smokowski, R.T. (West Valley Nuclear Services Co., Inc., West Valley, NY (USA)). 1 Dec 1985. Contract AC07-81NE44139. 50p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010127.

This is a report on the decontamination and refurbishment of five inactive contaminated analytical cells and six zinc bromide filled shielding windows. The analytical cells became contaminated during the nuclear fuel reprocessing carried out by Nuclear Fuel Services from 1966 to 1972. The decontamination and decommissioning (D & D) work was performed in these cells to make them useful as laboratories in support of the West Valley Demonstration Project. To accomplish this objective, unnecessary equipment was removed from these cells. Necessary equipment and the interior of each cell were decontaminated and repaired. The shielding windows, essentially tanks holding zinc bromide, were drained and disassembled. The deteriorated, opaque zinc bromide was refined to optical clarity and returned to the tanks. All wastes generated in this operation were characterized and disposed of properly. All the decontamination and refurbishment was accomplished within 13 months. The Analytical Hot Cell has been turned over to Analytical Chemistry for the performance high-level waste (HLW) characterization analysis.

31499 **(DOE/NE/44139—2) Initial decontamination of the equipment decontamination room at the West Valley Demonstration Project. Topical report, September 1983-May 1985.** Meigs, R.A. (West Valley Nuclear Services Co., Inc., West Valley, NY (USA)). Dec 1985. Contract AC07-81NE44139. 49p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010128.

The purpose of this report is to document the initial decontamination of the Equipment Decontamination Room (EDR). The effort spanned a two-year period and included packaging and removal of waste; grinding away contaminated concrete floors; pump-out and spraydown of an equipment soaking pit; washing and painting of walls, equipment, and floors; refurbishment of utilities and various pieces of equipment; and load tests of EDR and Chemical Process Cell (CPC) cranes. After decontamination, the EDR was converted into a waste handling area for the decommissioning of the CPC.

31500 **(DOE/NE/44139—3) Decontamination and decommissioning of Extraction Cell 3 at the West Valley Demonstration Project. Topical report, January 1982-April 1985.** Jones, E.D. (West Valley Nuclear Services Co., Inc., West Valley, NY (USA)). Dec 1985. Contract AC07-81NE44139. 56p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010129.

This report describes the decontamination and decommissioning (D & D) of Extraction Cell 3 (XC-3) at the West Valley Demonstration Project. XC-3 is one of several cells in the former reprocessing plant required for use in support of the solidification of high-level waste. It became radioactively contaminated during nuclear fuel reprocessing from 1966 to 1972. XC-3 contained systems used in the final uranium extraction cycle. Several pump niche and sample box drains were routed into the cell. The report describes the work performed to accomplish the D & D objectives of removing existing piping and equipment from XC-3 and to reducing radiation and contamination levels, to allow installation of equipment for the Liquid-Waste Treatment System (LWTS). Contaminated debris and equipment inside the cell were removed, packaged and stored for future disposition. Interior surfaces (walls, floor, and ceiling) of the cell were then decontaminated to a radiation level that allowed entry without the use of protective clothing or respiratory protection.

31501 **(DOE/NE/44139—4) Decontamination and renovation of the Master/Slave Manipulator Repair Shop and the Chemical Crane Room at the West Valley Demonstration Project. Final topical report, June 1982-June 1983.** Phillips, E.C.; Golden, M.P. (West Valley Nuclear Services Co., Inc., West Valley, NY (USA)). Jan 1986. Contract AC07-81NE44139. 40p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010531.

This report describes the decontamination and renovation of the Master/Slave Manipulator Repair Shop (MSMRS) and the Chemical Crane Room (CCR) at the WVDP from radioactively contaminated conditions to essentially shirt sleeve environments. In both cases, subsequent use recontaminated the rooms. Before decontamination, general exposure rates as high as 20 mrad/hr and surface contamination as high as 10^5 dpm/100 cm^2 were measured in the MSMRS, while general exposure rates in the CCR were 50 to 100 mrad/hr with hot spots as high as 2000 mrad/hr. Smearable levels on the floor in each room were in the range of 10^3 to 10^6 dpm per 100/cm^2. Respiratory protection was mandatory for entry into the CCR. The MSMRS, located at the north end of the Process Building on ground elevation, is needed for the refurbishment of plant manipulators and other equipment. The MSMRS has been decontaminated and renovated as follows: all tools, equipment and furnishings were removed, the walls were stripped and repainted, and the contaminated concrete floor was removed and disposal of as low-level waste. A new concrete floor was poured and a stainless steel liner covering the entire floor and extending 45.7 cm up the walls was added to provide the WVDP with a shop facility that can be easily decontaminated. Decontamination of the MSMRS has been completed and the facility is available for service. The CCR, located at the north end of the Chemical Process Cell (CPC) is for the storage and servicing of two bridge cranes used in the CPC. Decontamination and exposure reduction in the CCR has been completed using vacuum cleaning, damp wipe down, and surface grinding followed by shielding and painting.

31502 **(DOE/NE/44139—6) Comparison of the rotary calciner-metallic melter and the slurry-fed ceramic melter technologies for vitrifying West Valley high-level wastes.** Chapman, C.C. (West Valley Nuclear Services Co., Inc., West Valley, NY (USA)). 4 Feb 1983. Contract AC07-81NE44139. 72p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86010532.

Two processes which are believed applicable and available for vitrification of West Valley's high-level (HLW) wastes were technically evaluated and compared. The rotary calciner-metallic melter (AVH) and the slurry-fed ceramic melter (SFCM) were evaluated under the following general categories: process flow sheet, remote operability, safety and environmental considerations, and estimated cost and schedules.

31503 **(DOE/NE/44139—7) Decontamination and decommissioning of the extraction chemical room at the West Valley Demonstration Project. Final topical report, December 1982-April 1984.** Phillips, E.C. (West Valley Nuclear Services Co., Inc., West Valley, NY (USA)). Dec 1985. Contract AC07-81NE44139. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010533.

The purpose of this report is to describe the preparation of a facility for use in decontaminating and decommissioning (D & D) extraction cells at the West Valley Demonstration Project (WVDP). In order to prepare such a facility, it was necessary to decontaminate, decommission and equip the Extraction Chemical Room (XCR) at the WVDP. This report describes the D & D of the XCR from a radioactively contaminated condition to an essentially shirt sleeve environment. Also included is a description of the changes made to the XCR for use in the D & D of the extraction cells which are located beneath the floor of the XCR. In the XCR prior to D & D, radiological surveys indicated a maximum radiation field of 5 mrad/hr, due to sources internal to the room, and 20,000 dpm beta/100 cm^2 surface contamination. A radiation source external to the XCR caused a hot spot with a 9 mrad/hr exposure rate inside the XCR. The D & D of the XCR, located on the fifth floor elevation 48.8 m of the reprocessing plant at the WVDP, has been completed. D & D operations included removal of piping, tanks, supports, and equipment to provide a clean work area of about 278.7 m^2 and 5.2 m high. Subsequent to the removal of piping and equipment, a new floor was installed in part of the room and equipment for use in the D & D of the extraction cells was added. The equipment included a large containment tent over the extraction cell hatches, a jib crane, two gantries, a monorail crane, an air transporter, and a temporary ventilation system. D & D operations in the XCR were initiated in December 1982 and the completed facility was available for use in February 1984.

31504 **(DOE/RL/10582—3) Report on the vitrification and devitrification of Hanford, Washington soil. Final report.** King, J.A.; SubbaRao, S.C. (Lincoln Univ., PA (USA)). 1983. Contract AC06-84RL10582. 44p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010439.

This study as focused principally on the effects of melting or vitrification and recrystallization or devitrification on soil from the Hanford Reservation in Washington State. The fusion properties of soil are important because the containment of nuclear material in in-situ vitrified soil is a possible requirement. An understanding of the physical and chemical properties of the soil is important in determinaing how the soil can contain the nuclear material. The soil itself is composed of a plagioclastic feldspar, quartz, and hematite. The feldspar is made up of albite and anorthite. When the soil is heated, the first mineral to melt is the albite between 1100°C and 1200°C. The mineral anorthite melts above 1310°C and hematite below 1700°C. The quartz does not melt until the temperature exceeds 1715°C. The albite in the glass is sodium aluminosilicate. When the albite melts, microscopic spheres of non-crystalline, low-melting sodium silicate form. This indicates that the aluminosilicate matrix decomposes when heated. When crystals, which were previously fused, are heated: crystals begin to reform above 900°C. The minerals which crystallize are feldspar and magnetite, an iron oxide. Recrystallization should begin at a temperature 250°C below the liquidus point. The leaching of sodium, copper, calcium, and aluminum decreased with increasing fusion temperature, while the leaching of iron and barium increased with increasing fusion temperature.

31505 **(DOE/RW—0047-Vol.1) Analysis of the total system life cycle cost for the Civilian Radioactive Waste Management Program. Volume 1. The analysis and its results.** (USDOE Office of Civilian Radioactive Waste Management, Washington, DC). Apr 1986. 98p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010645.

The total-system life-cycle cost (TSLCC) analysis for the Department of Energy's (DOE) Civilian Radioactive Waste Management Program is an ongoing activity that helps determine whether the revenue-producing mechanism established by the Nuclear Waste Policy Act of 1982 is sufficient to cover the cost of the program. This report provides cost estimates for the fourth evaluation of the adequacy of the fee. The total-system cost for the reference authorized-system program is estimated to be 24 to 32 billion (1985) dollars. The total-system cost for the reference improved-performance system is estimated to be 26 to 34 billion dollars. A number of sensitivity cases were analyzed. For the authorized system, the costs for the sensitivity cases studied range from 21 to 39 billion dollars. For the improved-performance system, which includes a facility for monitored retrievable storage, the total-system cost in the sensitivity cases is estimated to be as high as 41 billion dollars. The factors that affect costs more than any other single factor for both the authorized and the improved-performance systems are delays in repository startup. A preliminary analysis of the impact of extending the burnup of nuclear fuel in the reactor was also performed; its results indicate that the impact is insignificant: the total-system cost is essentially unchanged from the comparable constant-burnup cases. The current estimate of the the total-system cost for the reference authorized system is zero to 3 billion dollars (9%) higher than the estimate for the reference system in the January 1985 TSLCC analysis.

31506 **(DOE/RW—0047-Vol.2) Analysis of the total system life cycle cost for the Civilian Radioactive Waste Management Program. Volume 2. Supporting information.** (USDOE Office of Civilian Radioactive Waste Management, Washington, DC). Apr 1986. 132p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86010646.

This report presents the detailed results and assumptions for the January 1986 Total System Life Cycle Cost (TSLCC) analysis. The report is composed of three sections: Section A lists the costing assumptions which have been made about the principal waste management system parameters; Section B presents the yearly flows of waste material between system facilities for the 8 logistics cases which were studied; and Section C presents the annual total system costs for each of the 32 TSLCC cases by major cost category.

31507 **(DPST—86-1-2) Savannah River Laboratory monthly report.** (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Feb 1986. Contract AC09-76SR00001. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010753.

Brief summaries are given in the areas of defense waste and laboratory operations, nuclear reactors and scientific computation, and chemical processes and environmental technology. The performance of waste glass samples has been tested. A prototype Pu-238 waste incinerator is being tested. A monitor system is being developed to allow unattended computer system operation. A program to review and update the Reactor Technical Standards and Specifications is in progress. Analysis of a medium LOCA in a reactor D_2O coolant system is reported. Preliminary results are given for alternative degreasers. Modernization of a JOSHUA computer system is reported. The safety of a fuel tube fabrication building is discussed. The program to evaluate reactor materials is summarized. A design has been developed for a silver-mordenite packed bed reactor to remove radioactive iodine from uranium fuel dissolver off-gas. Automated online analyzers were developed. Ground-penetrating radar has been evaluated. The safety of two space probes powered by plutonium dioxide thermal generators was evaluated. (LEW)

31508 **(EUR—9571) Study of elementary absorption in the marine sediments of the North Atlantic Ocean deeps.** Rancon, D.; Gueguenlat, P. (Commission of the European Communities, Luxembourg). 1984. 25p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751797.

We have studied the retention of actinide elements (Np, Pu, Am) and of Cs in the sediments of the ocean deeps around Cap-Vert. Plutonium: retention increases with temperatures of 4 to

30°C, then stays constant from 30 to 80°C. Desorption is slow. Americium: absorption is very strong at any temperature. Measurements of a wide variety of sediments show that retention is not affected by facies (including carbonated sediments). Neptunium: retention is more or less constant between 4 and 15°C, and distinctly higher at 30-50°C. It is reversible. Caesium: absorption decreases slightly from 4 to 30°C, but increases rapidly at 50 to 80°C. At the lowest temperatures it is reversible, but it appears to be irreversible at 50°. Cs absorption is subject to ponderal concentration. With equal amounts of activity, retention of Cs-135 is weaker than that of Cs-137: likewise the addition of the stable isotope causes in the amounts of Kd in Cs-137. Finally, this paper presents preliminary results showing the natural metallic element content of the sediments.

31509 **(EUR—9667) Study of the penetration of projectiles into marine sediments.** Boisson, J.Y. (Commission of the European Communities, Luxembourg). 1985. 96p. (In French). NTIS (US Sales Only), PC A05/MF A01. File Number DE86751795.

The work described in this document consists of three main parts: - Application, after having reviewed calculation methods and known codes, of a dynamic plasticity model based on the upper bound-method (with dissipated energy calculations by plastic deformations). The soil model used for this calculation is the Cambridge Clay Model. - Carrying out a programme of tests with instrumented small scale penetrators in centrifuge on a consolidated clay-target. The trials are done under 50 g, with projectiles, fired with an airgun at high impact velocity (50 m/s). The penetrators' instrumentation consists of either measuring acceleration, or tip force with strain gauges. - The mounting of a small instrumented penetrator for shallow water depth experimentations, with an accelerometer, and a local cell for tip resistance. A rapid electronic data acquisition system has been developed for these experimentations. The preliminary tests are done in a large tank filled with clay. The geotechnical characteristics of the clay are perfectly controlled. The tests performed under these conditions have shown the following observations: the rapid electronic data acquisition system works perfectly and could be used as a basic component for a deep water instrumentated penetrator; the results, obtained in these particular test conditions, are in a perfect agreement with the predictions of the model developed in the frame of this contract.

31510 **(EUR—10058) Methodology for evaluating radiological consequences of the management of very low-level solide waste arising from decommissioning of nuclear power plants.** Smith, G.M.; Hemming, C.R.; Clark, J.M.; Chapuis, A.M.; Garbay, H. (Commission of the European Communities, Luxembourg). 1985. 96p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86751799.

In this report a methodology is described, and illustrated by examples, for the evaluation of individual doses and collective dose commitments arising as a result of various management modes for very low-level solid wastes arising from the decommissioning of nuclear power plants. Estimates have been made of the masses of materials activated and contaminated to within three concentration limits, 0.37, 3.7 and 37 Bq g-1, at three times after reactor shutdown, 5 y, 25 y and 100 y. The disposal options considered are shallow land burial, at a municipal landfill site or at the reactor site, and disposal on the seabed in coastal waters or the deep ocean. It is assumed that there is no special treatment to reduce or eliminate the potential radiological hazard. Consideration has also been given to the radiological impact of recycling of contaminated steel. The radiological impacts of all the management options for the wastes considered were found to be small. It may therefore be acceptable to allow such very low-level wastes to be disposed of without special restrictions provided that the level and type of activity of the wastes can be verified. In addition the health detriment cost associated with all the management options is small, so it is likely that other factors such as transport and engineering costs will be more important in final decisions about the management of these wastes.

31511 **(EUR—10061) Feasibility studies for a radioactive waste repository in a deep clay formation.** Chapman, N.; Tassoni, E. (ed.). (Commission of the European Communities, Luxembourg). 1985. 210p. NTIS (US Sales Only), PC A10/MF A01. File Number DE86751798.

This report assesses the feasibility of deep geological disposal of long-lived, heat-emitting radioactive wastes produced from the Italian nuclear power programme. Disposal is envisaged in argillaceous formations of medium plasticity at depths between 200 and 3000 metres. Thermal and geotechnical data, together with information on cost and feasibility of construction techniques are used to devise two conceptual designs (repository or deep borehole disposal) for a facility to contain all the high-level wastes arising from a 10 GWe power programme. Alternative designs and their merits are discussed and assessed. The two reference designs are used to construct a simple model of long-term performance and safety of the proposed disposal system. Recommendations are made for further work required to develop these concepts into an operational facility. It should be borne in mind that since no definite area or site has yet been identified for a disposal facility, all considerations are purely generic. Consequently data on rock properties and geological environment represent average values or best estimates for those likely to be encountered in the regions currently being considered as suitable for deep diposal purposes, and several broad assumptions have had to be made. However, the designs presented could be adapted without difficulty on a site-specific basis when the results of further research become available.

31512 (INIS-BR—462, pp 370-376) **Porous glass with high silica content for nuclear waste storage: preparation, characterization and leaching.** Aegerter, M.A.; Santos, D.I. dos; Ventura, P.C.S. (Sao Paulo Univ., Sao Carlos, Brazil. Inst. de Fisica e Quimica; Vicosa Univ., Brazil. Dept. de Fisica). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

Aqueous solutions simulating radioactive nuclear wastes (like Savanah River Laboratory) were incorporated in porous glass matrix with high silica content prepared by decomposition of borosilicate glass like Na_2O - B_2O_3 - SiO_2. After sintering, the samples were submitted, during 28 days, to standard leaching tests MCC1, MCC5 (Soxhlet) and stagnating. The total weight loss, ph, as well as the integral and differential leaching rates and the accumulated concentrations in the leach of Si, Na, B, Ca, Mn, Al, Fe and Ni are given. The results are compared with the results from reference borosilicate glass, made by fusion, ceramic, synroc, concrets, etc.

31513 **(IOS-Rep—213) Distribution of glacial erratics in the Northeast Atlantic. Final report.** Huggett, Q. (Institute of Oceanographic Sciences, Godalming (UK)). 1985. 98p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86702084.

A detailed study of all the available information on glacial erratics has been carried out. This has included an examination of 288 dredge hauls, 1164 sediment cores and 176 camera runs. Sufficient data have now been collected to provide an estimate of the impact risk of a point projectile with a glacial erratic, down to oxygen isotope stage 5 (127,000 years) in three areas of the North East Atlantic. 1. Porcupine seabight (50 deg N, 14 deg W) 0.460%; 2. King's Trough Flank (42 deg N, 24 deg W) 0.502%; 3. Great Meteor East (31 deg N, 25 deg W) 0.015%. These estimates are for all erratics larger than 1.5 cm diameter and apply only down to oxygen isotope stage 5. If estimates are required at greater depths than this, it is proposed that a detailed study of a long core should be undertaken.

31514 **(IPNO-DRE—84-24) Accelerator for nuclear transmutation.** Schapira, J.P. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). 1984. 19p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751810.

A review on nuclear transmutation of radioactive wastes using particle accelerators is given. Technical feasibility, nuclear data, costs of various projects are discussed. It appears that one high energy accelerator (1500 MeV, 300 mA proton) could probably handle the amount of actinides generated by the actual French nuclear program.

31515 **(MLM—3351-OP) Application of a glass furnace system to low-level radioactive and mixed waste disposal.** Klingler, L.M.; Armstrong, K.M. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 1986. Contract AC04-76DP00053. 9p. (CONF-860429—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010414.

From 5. annual conference and exhibit on the incineration of low-level radioactive waste; Charlotte, NC, USA (23 Apr 1986).

In 1981 Mound began a study to determine the feasibility of using an electrically heated glass furnace for the treatment of low-level radioactive wastes generated at commercial nuclear power facilities. Experiments were designed to determine: (1) whether the technology offered solutions to industry waste disposal problems, and if so, (2) whether it could meet what were thought to be critical requirements for radioactive thermal waste processing. These requirements include: high quality combustion of organic constituents, capture and immobilization of radioactivity, integrity of final waste form, and cost effectiveness. To address these questions a variety of wastes typical of the types generated by nuclear power facilities, including not only standard trash but also wastes of high aqueous and/or inorganic content, were spiked with predominant waste radioisotopes predominant in plant wastes and processed in the glass furnace. The results of this study indicate that the unit is capable of fully meeting the addressed needs of the nuclear industry for power plant waste processing. The quality of combustion observed during the initial studies on the glass furnace was such that a more demanding application was suggested - that of hazardous waste processing. To fully evaluate the furnace's capabilities in this area a study was initiated in December, 1984 which simulated a "trial burn" of the type required for an EPA Part B permit for thermal processing of RCRA hazardous wastes. Solvents and sludges, some of which contained high percentages of water, were spiked with a "cocktail" of organics determined to be "difficult to incinerate" by the EPA. A complete sampling program following EPA protocol demonstrated destruction and removal efficiencies exceeding RCRA standards.

31516 **(MLM—3353-OP) Mitigating long term risk: an instrument for evaluating treatment, storage, and disposal facilities.** Wilson, S.C. (Monsanto Research Corp., Miamisburg, OH (USA). Mound). 1986. Contract AC04-76DP00053. 6p. (CONF-8604179—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010416.

From HAZPRO '86; Baltimore, MD, USA (1 Apr 1986).

A method for selecting a treatment, storage, and disposal facility vendor for hazardous waste disposal services is described. (LM)

31517 **(NVO—196-41) Nevada Nuclear Waste Storage Investigations project plan.** (Science Applications International Corp., Las Vegas, NV (USA)). Feb 1986. Contract AC08-83NV10270. 77p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010448.

In accordance with the Department of Energy's Order 5700 and instructions from the Office of Geologic Repositories, this Project Plan for the Nevada Nuclear Waste Storage Investigations (NNWSI) project has been developed in order to define the scope, the objectives, and the management requirements of the Project. The plan lists the technical, management, cost, schedule, and institutional objectives of the NNWSI Project; presents a technical plan that reflects the newly defined uniform work breakdown structure for the Office of Geologic Repositories; summarizes the management approach and acquisition strategy; and briefly discusses the principal risks associated with the project. In addition, the plan discusses cost estimation and presents projected costs through the completion of the development and evaluation phase; discusses the schedule for the NNWSI Project and the factors that may affect it directly or indirectly; and briefly reviews the controlled items for the Project. In format, scope, and content, this Project Plan follows closely the guidance given in DOE Order 5700.4A. Where appropriate, it focuses on potential difficulties that must be identified and resolved before they impede the progress of the Project. The Plan is part of the management documentation being developed for the NNWSI Project and is to be followed by a Project Management Plan. The NNWSI Project Plan is a supporting document to the Geologic Repository Project Plan.

31518 **(PTB-SE—7) Dose rates of waste packagings. A manual for activity determination of single radionuclide mixtures in standardized waste packagings resulting from dose rate limits.** Ehrlich, D.; Theis, P.; Thomauske, B. (Physikalisch-Technische Bundesanstalt, Braunschweig (Germany, F.R.). Abt. Sicherstellung und Endlagerung Radioaktiver Abfaelle). Jun 1985. 77p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE86751731.

This report gives a summary of shielding calculations for radioactive waste packages. A one-dimensional transport code (ANISN) was used for the container shielding calculations whereas for cylindrical waste packages, a Point-Kernel code (QUAD-CG) was used. Nuclide-specific calculations aiming at the determination of the dose rate at distances of 1 m and 2 m from the waste package surface were carried out for five key nuclides (Mn-54, Co-60, Ru-106, Cs-134, Cs-137) per unit of activity. With the results given in the Annex in the form of tables and, in some cases, additionally as graphs, the value of the dose rate for any mixture of radionuclides in different waste packages can be calculated using suitable summation rules. The results can be made use of for the specification of an appropriate conditioning (immobilization and/or packaging) of primary waste of given radionuclide composition. (orig./HP).

31519 (SAND—83-2551-Vol.2, pp 7-70) **Data report for current meters on Mooring CMMW-4, 1981; Pacific study area W-N.** Pillsbury, R.D.; Bottero, J.; Still, R.E.; Heath, G.R. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

The mooring designated CMMW-4 was installed on cruise W8103A by R/V Wecoma during March, 1981. It was recovered by the same ship 5 months later. All four meters from the mooring were recovered and gave good data. CMMW-4 is the continuation of the central series of W-N moorings (it was preceded by CMMW-1, 2, and 3). The series is designed to determined the long-term mean flow at W-N; and in combination with spatial data from CMMW-5 to 9, it will provide input data for a circulation model of the eastern Pacific. The CMMW-4 results re-establish the net SSE current trends evident in CMMW-1. The eddy-like feature in the CMMW-2 records has moved on. The low-frequency component of the deep meter records is quite coherent, but some shear is evident between 1250 and 3000 meters. 5 references, 54 figures, 1 tables.

31520 (SAND—83-2551-Vol.2, pp 71-152) **Data report for current meters on mooring CMME-1, 1980-81; Atlantic study area E-N3.** Pillsbury, R.D.; Bottero, J.; Still, R.E.; Laine, E.P. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

The mooring designated CMME-1 was installed by R/V Endeavor during September 1980. The installation was located on the northern Hatteras Abyssal Plain in an acoustically measured water depth of 5410 meters, and was recovered after 289.5 days of deployment. All five meters from the mooring were recovered and gave good data. The most notable feature in these records is the large number of low frequency events. These appear to be eddies or meanders in the flow regime which is generally to the northeast. The mean speeds increase linearly from 1070 to 4060 m. There is a decrease of 15% in the mean at 4910 m. The value at 5360 m (50 M above the bottom) is about the same as that at 4060 m. The maximum speeds recorded are greatest at 4060 m, with an almost linear decrease with either increasing or decreasing will be recovered in May of 1982 and will in turn, be replaced with a cluster of three moorings designed to continue the study of dominant scales of motion in this region. 3 references, 58 figures, 5 tables.

31521 (SAND—83-2551-Vol.2, pp 153-230) **Data report for current meters on mooring CMME-2, 1981-82; Atlantic study ar EN-3.** Pillsbury, R.D.; Bottero, J.; Root, D.C.; Simpkins, J. III; Laine, E.P. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

The mooring designated CMME-2 was installed by R/V Endeavor on the northern Hatteras Abyssal Plain in an acoustically measured water depth of 5410 corrected meters. It was recovered after 333 days of operation. All five meters were recovered. The speed sensor on the top meter failed after 3.5 months; therefore its speed and direction files are short. The bottom meter failed during installation and produced no data. CMME-2 is the second mooring in a planned series of moorings near the center of the study area E-N3. The series of moorings is designed to determine the long-term mean flow in the study area. The data collected will be used as input in a numerical circulation model of the region. In addition the long time series of data will allow the study of energetic fluctuations at low frequencies. The mean speeds recorded are lower than those from the earlier record. In contrast to the previous data there appears to be no subsurface speed maximum. There is a fairly consistent northerly flow on which is superimposed a more variable east-west flow. A seasonal trend may be present: flow to the east in spring, flow to the south in the fall, and flow to the north in winter. 4 references, 56 figures, 4 tables.

31522 (SAND—83-2551-Vol.2, pp 231-261) **Cruise report for R/V Wecoma cruises W8209A & B to Pacific study area W-N, September - October 1982.** Rea, D.; Huyer, A.; Lopez, C.; Ness, G.; Perhats, C.; Ruff, G.; Schramm, R.; Taber, D.; Windom, H. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

Cruise W8209A concentrated on CTD-nephelometer casts, on the recovery of 1-year and 3-year BAPL corrosion experiments, and on the recovery and deployment of 1-year current meter/sediment trap moorings. W8209B collected hydrocasts for radon analyses and for trace-metal studies, surface water samples for analyses of metals and nutrients, gravity cores for the determination of geotechnical properties and sedimentary processes, and box cores, three-quarters of each of which were used for benthic faunal analysis and the remaining quarter subsampled for microbiology and general sedimentology. 14 CTD casts were completed, along with 7 hydrographic sampling stations for radon and suspended sediments. 5 current meter/sediment trap moorings, 2 corrosion experiments and 14 cores were collected. One current meter/sediment trap mooring was put in place. 9 figures, 9 table.

31523 (SAND—83-2551-Vol.2, pp 262-392) **Data report on sediment cores collected on cruise W8103-A, Pacific study area W-N.** Heath, G.R.; Lopez, C.; Kovar, R. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

Cruise W8103-A of R/V Wecoma to Pacific study area W-N in March of 1981 recovered a total of 23 sediment cores. To allow comparison of a wide range of sediment properties, the cores were clustered in five locations distributed across the study area. The good visual correlation of cores and the lack of evidence for discontinuities in the recovered sections indicates that the low rise west of Delgada Fan has experienced hemipelagic deposition rather than bottom-current erosion or intermittent turbidite deposition during the past few hundred thousand years. 1 reference, 6 figures, 2 tables.

31524 (SAND—83-2551-Vol.2, pp 393-565) **Oceanographic studies through December 1982 at Pacific study area W-N.** Heath, G.R. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

Magnetic data show that the volcanic crust of the low rise occupying most of study area W-N formed by normal sea floor spreading 27-1/2 to 30 million years ago. Acoustic profiler records show that the valley between the toe of the Delgada Fan and W-N is filled with turbidite-bearing silty clays, but that the rise area is covered by uniformly layered pelagic-type silty clays. The deep currents (3800 and 4200m) trend parallel to the coast, with shallower currents (3000 and 1250 m) trending more offshore. The long-term net velocities are less than 1 cm/sec (1 km/day) at all levels. CTD and nephelometer profiles show that the benthic boundary layer can vary from well mixed and sharply defined to gradational over distances of kilometers and period of days. The layer is usually 100 to 300 m thick. Radon-222 data also indicate upward mixing of bottom tracers to heights of 300-400 m. Sediment trap samples indicate that most of the biogenic debris settles vertically to the site, but that about 40% of the terrigenous debris and as much as 70% of the manganese has been carried offshore from the continental margin. Measured sediment accumulation rates lie in the 1.5 to 4 cm/ky range. The turbidite valley deposits are strongly reduced (manganese depleted) with sand layers and variable water contents. The rise deposits are lithologically uniform clayey silts, with variable contents of biogenic calcite (reflecting past changes in the balance between supply and dissolution) and manganese (reflecting changes in the relative dominance of the fluxes of particulate manganese and organic matter). Analyses in progress will better characterize the areal variability of the deep circulation and of pelagic sedimentation over W-N. 106 references, 54 figures, 23 tables.

31525 (SAND—83-2551-Vol.2, pp 566-577) **Towing large nets by single warp at abyssal depths I: methods.** Stein, D.L.; Simonson, S. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

In December, 1981, members of the School of Oceanography at Oregon State University towed a midwater rope trawl of about 107 m^2 mouth area at abyssal and bathyal depths about 290 km west of Cape Mendocino, California. This was the first attempt to fish commercial-size nets at depths below 3000 meters. A total of 11 good otter trawl tows were obtained from 4300 m and 4 midwater trawl tows were made at depths from 2000-3100 m. The equipment and techniques required to tow commercial-size nets at bathyal and abyssal depths are described. The nets, doors and bridles of otter trawl and the midwater trawl are described. Depth monitors used are also described. The wire and winches used are also described, along with the difficulties encountered with gear failure. 7 references.

31526 (SAND—83-2551-Vol.2, pp 578-600) **Towing large nets by single warp at abyssal depth II: biological results.** Stein, D.L. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

This paper reports the biological results obtained from the commercial fishing vessels Golden Fleece and American Eagle fishing a midwater rope trawl and a North Sea otter trawl at depths from 2000-4350 m off Cape Mendocino, California. In the otter trawl collections, four families and eight species of benthic fishes were collected. Numbers and biomass of fishes in the bottom tows were highly variable. 9 families, 14 general and 15 species of fishes were collected in nets that opened and closed at depths between 2000 and 3100 m. Absolute and relative numerical abundances of fishes were low. The most numerous fish was never more common than one individual per $1.2 \times 10^5 m^3$. Nineteen decapod species were identified. Numbers, biomass, and species diversity of fishes clearly decreased with depth, but decapod crustaceans did not. 12 references.

31527 (SAND—83-2551-Vol.2, pp 601-626) **Progress research report, 27 June, 1983, benthic invertebrate studies.** Carey, A.G. Jr. (Oregon State Univ., Corvallis). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

The benthic ecological research at site W-N for the Low Level Waste Ocean Disposal Program is oriented towards characterizing the invertebrate community associated with the seafloor and towards understanding the links within the benthic food web. Stomach analyses of benthic-feeding fishes reveal a varied diet of benthic and peloagio-benthic forms. From the trawl samples of megafauna, the basic community structure is similar to other deep-sea

areas with echinoderms as the predominant forms. For the macrofauna, polychaete worms comprise the dominant taxonomic group. Very little is known about the fauna at area W-N on the species level. Such data will help answer the question of whether this community is characteristic of the continental slope base or is a transition between continentally-influenced communities and those in the central portion of ocean basins. Environmental differences within the area suggest that the benthic fauna should also vary in composition and abundance. 19 references, 7 figures, 5 tables.

31528 (SAND—83-2551-Vol.2, pp 627-259) **Benthic megafauna at deep-sea study areas W-N and E-N.** Keller, C.H. (Scripps Institution of Oceanography, La Jolla, CA). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

Photographs were utilized determine what megafaunal organisms live at areas E-N and W-N and in what densities. Life history characteristics gleaned from the literature as well as from the photographs are presented to establish these organisms' roles in oceanic food chains. In area W-N, the most abundant megafaunal group is the echinoderms. These are the asteroids, crinoids, echinoids, holothuroids, and ophiuroids. Dominant amongst the echinoderms are the ophiuroids, which account for about 46% of the total density. Taxonomic and photographic resolution at area E-N are both poor. Numbers of megafaunal organisms cannot be directly compared between areas E-N and W-N. Differing photographic techniques severely limit comparisons between the two areas. Nevertheless, megafauna seen at area E-N is apparently less dense and probably less diverse than at area W-N. 30 references, 8 figures, 8 tables.

31529 (SAND—83-2551-Vol.2, pp 660-682) **SNL Document number 16-5277, 2/3/82 and Amendment number 02, 2/18/83.** Feller, R.J. (Univ. of South Carolina, Columbia). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

This report summarizes results of studies carried out as part of the Low-Level Marine Disposal feasibility assessment. The studies are designed to: establish whether broadly reactive antibodies from shallow-water organisms will react with and recognize similar organisms from the deep sea; prepare antibodies to deep-sea organism for which no shallow-water antibody exists; and identify trophic connections among deep-sea organisms by means of immunological analysis. 3 figures, 8 tables.

31530 (SAND—83-2551-Vol.2, pp 683-696) **Interim status report: radiochemical studies in support of the low Level Waste Ocean Disposal Program.** Livingston, H.D. (Woods Hole Oceanographic Institution, MA). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

Isotope concentrations and ratios have been collected for both the Atlantic and Pacific Low-Level Waste Ocean Disposal sites. For the east coast site, and a broad Pu 239, 240 maximum was found at about 500-800 m depth, and nearly monotonically decreasing Cs 137 concentrations were found from surface to depth. When the deep water Pu concentrations are compared with those in the 3000-4000 m depth range, it is evident that the bottom water samples, exhibit a range of concentrations substantially higher than those in the waters immediately overlying them. It is assumed that this is in consequence to the release to deep water of Pu from sinking particles. At the west coast site, Pu and excess Pb 210 concentrations appear to be well correlated. Cs 137 shows poorer correlation at both stations than does Pu. Organic carbon measurements are in progress on both east and west coast cores to determine if they correlate with mixing rate (and hence, by implication, with organism population density). 2 figures, 12 tables.

31531 (SAND—83-2551-Vol.2, pp 697-717) **Preparation and deployment of the bottom ocean monitor for long term photographic observations of the sea floor.** Gardner, W.D. (Lamont-Doherty Geological Observatory, Palisades, NY). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

The components that make up the Bottom Ocean Monitor are described. The unit is designed to photographically record bottom fauna; the procedures used in testing on-board cameras are described. Recovery involves the use of a sonically-triggered release. The main instrument package then floats to the surface for retrieval by a research vessel; the base tripod remains on the ocean floor. Detailed specifications for component instruments are provided, and refurbishing procedures for each are given. 7 figures, 1 table.

31532 (SAND—83-2551-Vol.2, pp 718-791) **Northern Hatteras Abyssal Plain sediments: Geotechnical properties.** Laine, E.P.; Silva, A.; McCreery, C.; Lemmond, P.; Siciliano, R. (Univ. of Rhode Island, Narragansett). May 1985. NTIS, PC A99/MF A01. File Number DE85014147.

In Low-Level Waste Ocean Disposal Program. Annual technical progress report, June 1982-June 1983. Volume II.

Physical properties were tested on sediment cores in ten locations of the E-N3 study area of northern Hatteras Abyssal Plain. The sediments are composed of approximately 0.4 m of Holocene hemipelagic clay overlying interbedded tubiditic sands, silt, and clay of Pleistocene age. Physical properties tested include natural and remolded shear strength, water content, and bulk density. In most of the longer cores, normal downcore trends of physical properties were observed (i.e., water content decrease, shear strength increases, and bulk density increase). Turbidite silt and sand layers depart from these trends and have higher shear strength and bulk density, and lower water content. Summarized values of physical properties for northern Hatteras Abyssal Plain based on these cores are as follows: shear strength, 6.2 kPa; water content, 73%; bulk density, 1.62 mg/m^3. 3 references, 52 figures, 13 tables.

31533 (SAND—83-2551-Vol.3, pp 6-74) **Endeavor cruise 071 navigation and bathymetry, northern Hatteras Abyssal Plain.** Laine, E.P.; Friedrich, N.E.; McCreery, C.; Dickson, S.; Baker, M. (Univ. of Rhode Island, Narragansett). May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

Sub-bottom seismic profiling was carried out by R/V Endeavor during the summers of 1980 and 1981. Data collection was concentrated in LLWODP study area E-N3, which encompasses the northern Hatteras Abyssal Plain and the adjacent lower continental rise. Time, position, and depth were logged and marked on the seismic record at 15-minute intervals. These navigational and bathymetric data have been used to produce a time/position/depth listing, and a detailed bathymetric map of the northern Hatteras Abyssal Plain and surrounding physiographic provinces. 6 figures, 1 table.

31534 (SAND—83-2551-Vol.3, pp 75-114) **Pore water geochemistry and the oxidation of sedimentary organic matter: Hatteras Abyssal Plain 1981.** Heggie, D.; Lewis, T.; Graham, D. (Univ. of Rhode Island, Narragansett). May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

This report presents the pore water geochemistry from R/V an Endeavor cruise to an area of the Hatteras Abyssal Plain between 31° 45′ - 34° 00′N and 69° 37.5 - 72° 07.5′W. The authors report on the down core variations of the products of organic matter oxidation, the stoichiometry of reactions and make a preliminary assessment of the rates of organic matter oxidation at several core locations. The authors found concentrations of total inorganic nitrogen species; nitrate, nitrite and ammonia in pore waters to be less than those predicted from a model of organic matter oxidation (Froelich et al. 1979) in sediments. The observations indicate that nitrogen is depleted over carbon as compared to typical marine organic matter. The down-core nitrate profiles over the study area were used to infer depths at which oxygen is near totally consumed in the sediments and hence to compute rates of oxygen consumption. The authors found oxygen consumption rates to vary by nearly an order of magnitude between core locations (1.7 - $>15 \mu mO_2$ cm^{-2} yr^{-1}). A simple model which combines the com-

puted rates of oxidant consumption and the stoichiometry of organic matter oxidation was used to make estimates of organic carbon oxidation rates. These latter were found to vary between 1.3 and > 11.5 $\mu m\ C\ cm^{-2}\ yr^{-1}$. Highest carbon oxidation rates were found at the western boundary of the study area, and in all cases oxygen consumption was responsible for >85% of carbon oxidized. 11 references, 5 figures, 4 tables.

31535 (SAND—83-2551-Vol.3, pp 115-140) **Cruise report R/V Endeavor cruise EN-084 North Atlantic May 15-24, 1982.** Laine, E.P.; Friedrich, N.E. (Univ. of Rhode Island, Narragansett). May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

Under investigation during Endeavor EN-084 (May 15-25, 1982) was the northern half of the LLWODP lower continental rise study area, E-N2, located between 36° 00′ - 37° 00′N and 71° 00′ - 72° 30′W. 2200 track km of 3.5 kHz sub-bottom acoustic profiles were obtained. Eleven box cores, 5 gravity cores, and 1 piston core were attempted; and 7 camera lowerings, 4 hydrocasts, and 4 harpoon (in situ pore water sampler) lowerings were carried out. In addition, 8 free-vehicle (biol.) traps and 2 free-vehicle sediment samplers were deployed. 3 figures, 10 tables.

31536 (SAND—83-2551-Vol.3, pp 141-175) **Cruise report Endeavor cruise EN-085 North Atlantic May 27-June 8, 1982.** Laine, E.P.; Fisher, J. (Univ. of Rhode Island, Narragansett). May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

The main operations of Endeavor Cruise EN-085 (May 27 - June 8, 1982) were conducted within the LLWODP Hatteras Abyssal Plain study location E-N3 located between 31° 00 - 34° 00′N; 69° 00′ - 73° 00′W. Additional operations were carried out within the LLWODP study location E-N2 situated on the lower continental rise (36° 00′ - 37° 00′N; 71° 00′ - 72° 30′W). In total, 2471 track km of 3.5 kHz subbottom acoustic profiles were obtained. Within E-N3 study location, 3 piston cores, 2 sphincter cores, 2 gravity cores and 4 boomerang cores were attempted; one current meter mooring (CMME-2) was recalled and 2 current meter moorings (CMME-4 and CMME-5) were installed; and 6 pogo camera lowerings, 7 CTD with transmissometer lowerings and 3 pinger probe lowerings were carried out. In addition, an unsuccessful attempt was made to retrieve components of instrumented mooring CMME-3. In route between study locations E-N3 and E-N2, one CTD with transmissometer lowering was carried out within the lower continental rise hills province. One current meter mooring (CMME-6) and one Bottom Ocean Monitor were deployed; one CTD with transmissometer lowering was carried out, and one piston core was attempted within E-N2 study location. 9 figures, 11 tables.

31537 (SAND—83-2551-Vol.3, pp 176-199) **Seismic echo character northern Hatteras Abyssal Plain.** McCreery, C.J.; Laine, E.P. May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

Latest efforts in echo-character mapping of the northern Hatteras Abyssal Plain have discerned variations in thickness in a near-surface sedimentary sequence which has been designated seismic unit A. This unit probably represents the last episode of progradation of the Hatteras Deep Sea Fan in the southern part of the study area, and has infilled probable paleochannels from the Wilmington Canyon and Sohm Gap in the north. Unit A thins to a minimum in the central part of the plain, where older sediments come within 1 meter of the surface. Variations in the character of the surface reflector probably represent differing degrees of microtopography developed on a Late Pleistocene surface overlain by Holocene sediments. With the exception of one area identified as a relict surface outcropping in the western plain, this microtopography seems related to present-day thalweg locations on the abyssal plain. 11 references, 13 figures.

31538 (SAND—83-2551-Vol.3, pp 200-208) **Bathymetry and acoustic echo character lower continental rise study area, E-N2.** Laine, E.P.; Friedrich, N.E. (Univ. of Rhode Island, Narragansett). May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

A bathymetric map of area E-N2 was constructed using navigational and bathymetric data supplied by the Defense Mapping Agency and navigational and bathymetric data obtained during Endeavor cruises. E-N2 contains two dominant echo-types: an area of submarine canyons, and an area of levee deposits and debris flow deposits. The canyon system is complex, characterized by many channels and inter-channel levee deposits. The second echo province, characterized by levee and debris flow deposits, is a region suitable for the proposed operations (low-level radioactive waste disposal). Given a favorable analysis of data collected on cruise EN-084, attention will be focused at shallower depths to determine slope stability and other seabed conditions. 4 figures.

31539 (SAND—83-2551-Vol.3, pp 209-255) **Report on suspended particulate analyses.** Laine, E.P.; Isley, A.; Fisher, J.C. (Univ. of Rhode Island, Narragansett). May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

Twenty hydrocasts with a CTD and SEATECH 1 m transmissometer were made in E-N2 and E-N3 during cruises 069 and 085 of R/V Endeavor. Information gained during these cruises showed that the height of the benthic well-mixed layer and concentration of suspended particulate matter varied considerably, from 18-180 meters and approximately 25-1500 $\mu g/l$. These variations occurred independently of topography or time. Interior nepheloid layers were noted in two of the eighteen profiles and it is possible that they exist in six others. Calibration of the transmissometer through filtration studies was completed; the favored calibration suggests a linear relationship of 0.36:1 between suspended particulate ($\mu g/l$) and transmissivity (delnbits). 25 references, 5 figures, 6 tables.

31540 (SAND—83-2551-Vol.3, pp 256-354) **Lithology and surficial sediment distribution: northern Hatteras Abyssal Plain.** Dickson, S.M.; Laine, E.P.; Friedrich, N.E. May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

Surficial sediments of the LLWODP study area E-N3 have several common characteristics and a few anomalous features. All of the 26 surficial samples examined are Holocene in age. In E-N3, the Holocene sequence ranges from 12-90 cm. The sequence is composed primarily of brown foraminiferal lutite. The lutites show evidence of burrowing by benthic animals in the form of burrows infilled with sediment of a different color. Below the bioturbated lutites is a dark brown, iron-enriched horizon stratigraphically near (within a few centimeters of) the Pleistocene/Holocene boundary. The vertical extent of this unit, which ranges from 2-22 cm, varies systematically within the study area. The maximum thickness is found in a region most removed from the terrigenous sediment entry points. Fine-grained turbidity currents, an abyssal current, and a debris flow created the uncommon features of the surficial sediments. The areal extent of these deposits is estimated as 10% of the E-N3 region below 5300 m. The largest turbidite is probably greater than 2000 km^2 in extent. However, evidence of coarse-grained turbidity current activity in the Holocene is absent. Hemipelagic deposition during the Holocene has resulted in a texturally uniform sequence of surficial sediments. 22 references, 10 figures, 6 tables.

31541 (SAND—83-2551-Vol.3, pp 355-414) **Northern Hatteras Abyssal Plain sediments (EN-071) geotechnical analyses.** Levy, W.P.; Laine, E.P.; Silva, A.J.; Dickson, S.M.; Friedrich, N.E. May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

Cores collected by the Endeavor during its cruise of the E-N3 area were subjected to laboratory testing which included classification, consolidation, and triaxial compression. Index properties (classification) included: specific gravity, liquid and plastic limit, and grain size. Index property variation from site to site is strongly dependent on position of cores relative to the depositional lobes of the area, which correlate to the sediment entry points of the region. All cores analyzed contain evidence of textural characteristics typical of turbidite deposits. Core PC-10, located proximally to the Hatteras Transverse Canyon, is dominated by coarse and fine components of a major turbidite deposit while cores PC-01, PC-03 and PC-07 are characterized by clay interbedded with thin sand and silt layers. 5 references, 17 figures, 1 table.

31542 (SAND—83-2551-Vol.3, pp 415-749) **Endeavor cruises 053, 069, and 085 CTD and hydrographic data report.** Laine, E.P.; Benttinen, T.; Fisher, J.; Isley, A.; Lillibridge, J.; Smith, J.; Szelag, J. (Univ. of Rhode Island, Narrangansett). May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

A total of 31 CTD lowerings was carried out during three cruises, EN-053, EN-069 and EN-085, within the area of the Hatteras Abyssal Plain, Lower Continental Rise and Bermuda Rise. Parameters of temperature, conductivity, pressure, and oxygen were recorded on all lowerings. Transmissivity was measured on all but the first seven lowerings using a SEATECH lm Transmissometer and the data were correlated to organic and inorganic suspended particulate matter measurements. In excess of 700 separate salinity and oxygen measurements, 200 thermometric pressure measurements and 400 temperature measurements were taken using a rosette sampler. On EN-085, silicate samples were also taken. CTD data were calibrated using corrected hydrographic data and pre- and post-cruise laboratory calibrations. Comparison of CTD data to historical data showed that the CTD functioned well on all lowerings. 27 references, 1 figure, 3 tables.

31543 (SAND—83-2551-Vol.3, pp 750-789) **Cruise report Endeavor cruise EN-098 North Atlantic April 23-May 4, 1983.** Laine, E.P.; Smith, J.K. (Univ. of Rhode Island, Narragansett). May 1985. NTIS, PC A99/MF A01. File Number DE85013756.

In Low-Level Waste Ocean Disopsal Program. Annual technical progress report June 1982-June 1983. Volume III.

The main operations of Endeavor Cruise EN-098 (April 23 - May 4, 1983) were conducted within and between two study locations: E-N2 located over the lower continental rise (36°00′ - 37°00′N; 71°00′ 72°30′W); and E-N3 encompassing the northern portion of the Hatteras Abyssal Plain (31°00′ - 34°00′; 69°00′ 73°00′). A total of 2780 track km of 3.5 kHz subbottom acoustic profiles were obtained. Recovery operations included 3 current meter moorings (CMME-3, CMME-4, CMME-6) deployed during EN-085 (1982) as well as a Bottom Ocean Monitor also installed during EN-085. Seven current meter moorings (CMME-7 through CMME-13) were successfully installed; 3 pinger probes, 8 pogo launches, and 1 large volume water hydrocast were carried out. In addition, 17 CTD with transmissometer casts (CTD-1 through CTD-16-2) were attempted. 13 figures, 9 tables.

31544 **(SAND—86-0143) 1983 Subseabed Disposal Program: Systems. Annual report, October 1982-September 1983.** Klett, R.D. (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 114p. NTIS, PC A06/MF A01; 1; GPO Dep: File Number DE86010631.

This report describes the FY83 Systems activities conducted by the Subseabed Disposal Program (SDP). Included are waste package, geological, biological, and physical oceanographic sensitivity studies, a definition of the reference system, and preliminary pre and postemplacement rdiological safety assessments. Radiological standards for the SDP and a new method of performance assessment are discussed.

31545 **(UNI-SA—172) Data submittal to the DOE integrated data base.** Spence, S.T. (UNC Nuclear Industries, Inc., Richland, WA (USA)). 23 Apr 1986. Contract AC06-76RL01857. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010606.

The projected schedule for current projects of the Surplus Facilities Management Program is given. (LM)

31546 **Method for extracting lanthanides and actinides from acid solutions.** Horwitz, E.P.; Kalina, D.G.; Kaplan, L.; Mason, G.W. (to Dept. of Energy). US Patent 4,548,790. 22 Oct 1985. Filed date 21 Jul 1983. vp.

PAT-APPL-517475.

A process for the recovery of actinide and lanthanide values from aqueous acidic solutions with an organic extractant is patented. The process is suitable for the separation of actinide and lanthanide values from fission product values found together in high-level nuclear reprocessing waste solutions.

31547 **Method of storing radioactive wastes using modified tobermorite.** Komarneni, S.; Roy, D.M. (to Dept. of Energy). US Patent 4,537,710. 27 Aug 1985. Filed date 31 Oct 1983. vp.

PAT-APPL-547266.

A new cation exchanger is a modified tobermorite containing aluminum isomorphously substituted for silicon and containing sodium or potassium. The exchanger is selective for lead, rubidium, cobalt and cadmium and is selective for cesium over calcium or sodium. The tobermorites are compatable with cement and are useful for the long-term fixation and storage of radioactive nuclear wastes.

31548 **Natural convection experiments about a finite-length cylindrical heat source in a liquid-saturated porous medium.** Reda, D.C. New York, NY; American Institute of Chemical Engineers (1985). 29p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC04-76DP00789.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

An experimental effort is under way to investigate convective heat transfer in liquid-saturated porous media utilizing a geometry, and hydrodynamic/thermal boundary conditions, relevant to the problem of nuclear waste isolation in geologic repositories. In the present work, measurements were made of the transient and steady-state thermal fields throughout an annular region bounded by vertical, coaxial cylinders. The inner cylinder was comprised of a finite-length heat source, supported above and below by insulating sections; the outer cylinder was maintained at a constant temperature temperature. An overlying liquid layer was used to impose a permeable upper-surface boundary condition; this layer was maintained at a constant temperature equal to that of the outer cylinder. All properties of the porous medium, including porosity, permeability, and effective thermal conductivity were measured. Experimental results obtained in this effort showed steady-state heater surface temperatures (at constant heater power) to increase with increasing vertical distance due to the buoyantly driven upflow. The measured steady-state radial temperature drop across the annulus was found to systematically depart from the finite-length-cylinder conduction solution as heater power was increased. Comparisons between measured results and numerical predictions obtained using the finite-element code MARIAH showed very good agreement, thereby contributing to the qualification of this code for repository-design applications.

31549 **Salt pressures on defense high-level waste packages.** Nelson, D.P.; Fossum, A.F. (RE/SPEC Inc., Rapid City, SD). pp 251-258 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—). Contract AC02-83CH10140.

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

This paper demonstrates that salt pressures on defense high-level waste packages proposed for high-level nuclear waste reposi-

tories depend significantly on whether or not an air gap exists between the waste package and the surrounding salt. When an air gap is present, the ultimate radial stresses on the waste package are calculated to be much less than when the air gap is not present.

31550 **Hydraulic-fracture growth in dipping anisotropic strata as viewed through the surface deformation field.** Holzhausen, G.R.; Haase, C.S.; Stow, S.H.; Gazonas, G. (Applied Geomechanics, Inc., Santa Cruz, CA). pp 341-354 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—).

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

In 1983 and 1984 Oak Ridge National Laboratory conducted a series of precision ground deformation measurements before, during, and after the generation of several large hydraulic fractures in a dipping member of the Cambrian Conassauga Shale. Each fracture was produced by the injection of approximately 500,000 liters of slurry on a single day. Injection depth was 300 m. Leveling surveys were run several days before and several days after the injections. An array of eight high-precision borehole tiltmeters monitored ground deformations continuously for a period of several weeks. Analysis of the leveling and the tilt measurements revealed surface uplifts as great as 25 mm and tilts of tens of microradians during each injection. Furthermore, partial recovery (subsidence) of the ground took place during the days following an injection, accompanied by shifts in the position of maximum resultant uplift. Interpretation of the tilt measurements is consistent with stable widening and extension of hydraulic fractures with subhorizontal orientations. Comparison of the measured tilt patterns with fracture orientations established from logging of observation wells suggests that shearing parallel to the fracture planes accompanied fracture dilation. This interpretation is supported by measured tilts and ground uplifts that were as much as 100 percent greater than those expected from fracture dilation alone. Models of elastically anisotropic overburden rock do not explain the measured tilt patterns in the absence of shear stresses in the fracture planes. This work represents the first large-scale hydraulic-fracturing experiment in which the possible effects of material anisotropy and fracture-parallel shears have been measured and interpreted.

31551 **Low-level radioactive wastes in subsurface soils.** Francis, A.J. (Brookhaven National Lab., Upton, NY). pp 279-331 of Soil reclamation processes: microbiological analyses and applications. Tate, R.L. III; Klein, D.A. New York, NY; Marcel Dekker, Inc. (1985). Contract AC02-76CH00016.

Low-level radioactive wastes will continue to be buried in shallow-land waste disposal sites. Several of the burial sites have been closed because of the problems that developed as a result of poor site characteristics, types of waste buried, and a number of other environmental factors. Some of the problems encountered can be traced to the activities of microorganisms. These include microbial degradation of waste forms resulting in trench cover subsidence, production of radioactive gases, and production of microbial metabolites capable of complexation, solubilization, and bioaccumulation of radionuclides. Improvements in disposal technology are being developed to minimize these problems. These include waste segregation, waste pretreatment, incineration, and solidification. Microorganisms are also known to enhance and inhibit the movement of metals. Little is known about the role of autotrophic microbial transformations of radionuclides. Such microbial processes may be significant in light of improved disposal procedures, which may result in reductions in the organic content of the waste disposed of at shallow-land sites. 102 references, 5 figures, 19 tables.

31552 **WIPP waste package testing on simulated DHLW: emplacement.** Molecke, M.A. (Sandia National Labs., Albuquerque, NM). pp 265-271 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC04-76DP00789.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Several series of simulated (nonradioactive) defense high-level waste (DHLW) package tests have been emplaced in the WIPP, a research and development facility authorized to demonstrate the safe disposal of defense-related wastes. The primary purpose of these 3-to-7 year duration tests is to evaluate the in situ materials performance of waste package barriers (canisters, overpacks, backfills, and nonradioactive DHLW glass waste form) for possible future application to a licensed waste repository in salt. This paper describes all test materials, instrumentation, and emplacement and testing techniques, and discusses progress of the various tests. These tests are intended to provide information on materials behavior (i.e., corrosion, metallurgical and geochemical alterations, waste form durability, surface interactions, etc.), as well as comparison between several waste package designs, fabrications details, and actual costs. These experiments involve 18 full-size simulated DHLW packages (approximately 3.0 m x 0.6 m diameter) emplaced in vertical boreholes in the salt drift floor. Six of the test packages contain internal electrical heaters (470 W/canister), and were emplace under approximately reference DHLW repository conditions. Twelve other simulated DHLW packages were emplaced under accelerated-aging or overtest conditions, including the artificial introduction of brine, and a thermal loading approximately three to four times higher than reference. Eight of these 12 test packages contain 1500 W/canister electrical heaters; the other four are filled with DHLW glass. 9 refs., 1 fig.

31553 **Behavior of carbon-14 in waste packages for spent fuel in a repository in tuff.** Van Konyenburg, R.A.; Smith, C.F.; Culham, H.W.; Otto, C.H. Jr. (Lawrence Livermore National Lab., CA). pp 405-412 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract W-7405-ENG-48.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Analysis of gas from a heated air-filled canister containing a spent fuel assembly before and after rupture of a fuel rod shows that about 1.5 mCi of ^{14}C from the external surface of the assembly was rapidly oxidized and released as $^{14}CO_2$ in excess oxygen at 275°C and 10^4 /sup rad//hr. After rupture, an additional 0.3 mCi was released, probably also from the external surface. The total ^{14}C inventory in the entire 15 x 15 rod assembly including structural hardware is estimated to be 690 mCi. These measurements indicate that accounts will have to be taken of the time distribution of lifetimes of the canisters, and a broad definition of the "engineered system" may be necessary, in order to meet 10CFR60 requirements with spent fuel in a repository in tuff. 22 refs., 1 tab.

31554 **Conceptual model for deriving the repository source term.** Alexander, D.H.; Apted, M.J.; Liebetrau, A.M.; Van Luik, A.E.; Williford, R.E.; Doctor, P.G. (Department of Energy, Washington, DC; Pacific Northwest Lab., Richland, WA; Roy F. Weston, Inc./Rogers and Assoc. Engineering Corp., Rockville, MD). pp 439-450 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Part of a strategy for evaluating the compliance of geologic repositories with Federal regulations is a modeling approach that would provide realistic release estimates for a particular configuration of the engineered-barrier system. The objective is to avoid worst-case bounding assumptions that are physically impossible or excessively conservative and to obtain probabilitistic estimates of (1) the penetration time for metal barriers and (2) radionuclide-release rates for individually simulated waste packages after penetration has occurred. The conceptual model described in this paper will assume that release rates are explicitly related to such time-dependent processes as mass transfer, dissolution and precipitation, radionuclide decay, and variations in the geochemical environment. The conceptual model will take into account the reduction in the rates of waste-form dissolution and metal corrosion due to a build-up of chemical reaction products. The sorptive properties of the metal-barrier corrosion products in proximity to the waste form surface will also be included. Cumulative released from the engi-

neered-barrier system will be calculated by summing the releases from a probabilistically generated population of individual waste packages. 14 refs., 7 figs.

31555 **Salton Sea geothermal field as a natural analog for the near-field in a salt high-level nuclear waste repository.** Elders, W.A.; Moody, J.B. (Univ. of California, Riverside; Battelle Memorial Inst., Columbus, OH). pp 565-572 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Salton Sea Geothermal Field (SSGF), on the delta of the Colorado River in southern California, is being studied as a natural analog for the near-field environment of proposed nuclear waste repositories in salt. A combination of mineralogical and geochemical methods is being employed to develop a three-dimenisonal picture of temperature, salinity, lithology, mineralogy, and chemistry of reactions between the reservoir rocks and the hot brines. Our aim is to obtain quantitative data on mineral stabilities and on mobilities of the naturally occurring radionuclides of concern in Commercial High-Level Waste (CHLW). These data will be used to validate the EQ3/6 geochemical code under development to model the salt near-field repository behavior. Maximum temperatures encountered in wells in the SSGF equal or exceed peak temperatures expected in a salt repository. Brines produced from these wells have major element chemistry similar to brines from candidate salt sites. Relative to the rocks, these brines are enriched in Na, Mn, Sr, Ra, and Po, depleted in Ba, Si, Mg, Ti, and Al, and strongly depleted in U and Th. However, the unaltered rocks contain only about 2 to 3 ppm of U and 4 to 12 ppm of Th, largely in detrital epidotes and zircons. Samples of hydrothermally altered rocks from a wide range of temperature and salinity show rather similar uniform low concentrations of these elements, even when authigenic illite, chlorite, ipidote and feldspar are present. These observations suggest that U and Th are relatively immobile in these hot brines. However, Ra, Po, Cs, and Sr are relatively mobile. Work is continuing to document naturally occurring radionuclide partitioning between SSGF minears and brine over a range of temperature, salinity, and lithology. 8 refs., 7 figs., 2 tabs.

31556 **Purpose of the Materials Characterization Center.** Mendel, J.E. (Pacific Northwest Lab., Richland, WA). pp 711-716 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Materials Characterization Center (MCC) at the Pacific Northwest Laboratory is the experimental arm of the Materials Characterization Organization (MCO), which was established by the US Department of Energy (DOE) in FY 1980 to ensure high quality characterization and qualification of waste package materials essential to the reliable performance of DOE nuclear waste management programs. The MCC is responsibe for publishing key test methods and data in the Nuclear Waste Materials Handbook (DOE/TIC-11400) after the methods and data have been reviewed and approved by the Materials Review Board (MRB), which is the other major operating arm of the MCO. The MCC is carrying out its responsibilities in several ways. It sponsors a continuing series of workshops that address materials characterization test method issues. It supplies well-characterized reference and testing materials for use by the DOE nuclear waste management programs. It develops generic tests methods and supports the repository waste package projects in developing selected site-specific test methods and performing confirmatory testing of these methods. When these test methods are approved by the MRB they constitute the formal tests to be used by laboratories to test and qualify materials, evaluate waste package components, and assure compliance with standards and/or specifications for the final product.

31557 **Functions of the materials review board.** Steindler, M.J.; Seefeldt, W.B. (Argonne National Lab., IL). pp 717-722 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

This paper addresses the organization and functions that have been assembled to aid in establishing the qulity of materials data that are important in the licensing of a repository.

31558 **Reference and testing materials available from the Materials Characterization Center.** Daniel, J.L.; Mellinger, G.B.; Barner, J.O. (Pacific Northwest Lab., Richland, WA). pp 723-728 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

A major responsibility of the Materials Characterization Center (MCC) is to acquire and distribute reference and testing materials endorsed by DOE, for use in research and development in nuclear waste management. MCC standard materials provide a common basis for data obtained in waste repository development work, thereby assisting in developing a defensible database of known accuracy and precision. Homogeneity of standard materials is of particular importance. MCC emphasizes homogeneity of composition and physical characteristics of the standard materials, using statistical methods in sampling procedures and evaluation of analytical data. Two classifications of standard materials are available from the MCC. Approved Reference Materials (ARMs) are intended as standard reference and calibration materials [similar to the SRMs of the US National Bureau of Standards (NBS)], for field calibration of MCC standard test methods. Each ARM is characterized by MCC and other laboratories such as NBS to a high level of accuracy and precision. Approved Testing Materials (ATMs) are used as common testing materials, representing specific formulations of typical waste forms. Most ATMs are radioactive materials, for which characterization has been conducted on shielded analytical instruments at PNL. More than ten different ATMs (borosilicate glass and spent fuel) are in the MCC inventory. These materials are available without charged, in reasonable amounts, to DOE programs. Other users pay pro-rated production costs. The materials normally are supplied in the form in which they were produced, e.g., glass as-cast bars. In some cases the MCC can supply special specimen forms, e.g., crushed powders or shaped monoliths.

31559 **Hot cells preparation of testing materials.** Thornhill, R.E.; Knox, C.A. (Battelle Pacific Northwest Labs., Richland, WA). pp 735-740 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

It is important in nuclear waste repository development that testing be done with materials containing a radionuclide spectrum representative of actual wastes. To meet the need for such materials, the Materials Characterization Center (MCC) has prepared simulated high-level waste (HLW) glasses with radionuclides representative of about 10-, 300- and 100-year-old waste. A quantity of well characterized spent fuel also has been acquired for the same purpose. Glasses containing 10- and 300-year-old wastes, and the spent fuel specimens, must be fabricated in a hot cell. Hot cell conditions (high radiation field, remote operation, and difficulty of repairs) require that procedures and equipment normally used in materials preparation out-of-cell be modified for hot cell applications. This paper discusses the fabrication of two glasses, and the preparation of test specimens of these glasses and spent fuel. One of the glasses is a 76-68 composition, which is fully loaded with actual commercial reactor fission product waste. The other glass contains simulated Barnwell Nuclear Fuel Plant waste, doped with different combinations of fission products and actinides. The spent fuel is a 10-year-old PWR material. Special techniques have been used to achieve high quality, well characterized testing materials, including

specimens in the form of segments, wafers, cylinders, and powders of these materials.

31560 **Standardized waste form test methods.** Slate, S.C. (Pacific Northwest Lab., Richland, WA). pp 741-746 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Materials Characterization Center (MCC) is developing standard tests to characterize nuclear waste forms. Development of the first thirteen tests was originally initiated to provide data to compare different high-level waste (HLW) forms and to characterize their basic performance. The current status of the first thirteen MCC tests and some sample test results are presented: the radiation stability tests (MCC-6 and 12) and the tensile-strength test (MCC-11) are approved; the static leach tests (MCC-1, 2, and 3) are being reviewed for full approval; the thermal stability (MCC-7) and microstructure evaluation (MCC-13) methods are being considered for the first time; and the flowing leach test methods (MCC-4 and 5), the gas generation methods (MCC-8 and 9), and the brittle fracture method (MCC-10) are indefinitely delayed. Sample static leach test data on the ARM-1 approved reference material are presented. Established tests and proposed new tests will be used to meet new testing needs. For waste form production, tests on stability and composition measurement are needed to provide data to ensure waste form quality. In transporation, data are needed to evaluate the effects of accidents on canisterized waste forms. The new MCC-15 accident test method and some data are presented. Compliance testing needs required by the recent draft repository waste acceptance specifications are described. These specifications will control waste form contents, processing, and performance.

31561 **Role of statistics in characterizing nuclear waste package behavior.** Bowen, W.M. (Pacific Northwest Lab., Richland, WA). pp 747-752 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The characterization of nuclear waste package behavior is primarily based on the outcome of laboratory tests, where components of a proposed waste package are either individually or simultaneously subjected to simulated repository conditions. At each step of a testing method, both controllable and uncontrollable factors contribute to the overall uncertainty in the final outcome of the test. If not dealt with correctly, these sources of uncertainty could obscure or distort important information that might otherwise be gleaned form the test data. This could result in misleading or erroneous conclusions about the behavior characteristic being studied. It could also preclude estimation of the individual contributions of the major sources of uncertainty to the overall uncertainty. Statistically designed experiments and sampling plans, followed by correctly applied statistical analysis and estimation methods will yield the most information possible for the time and resources spent on experimentation, and they can eliminate the above concerns. Conclusions reached on the basis of such information will be sound and defensible. This presentation is intended to emphasize the importance of correctly applied, theoretically sound statistical methodology in characterizing nuclear waste package behavior.

31562 **Cleanout of waste storage tanks at Oak Ridge National Laboratory.** Weeren, H.O.; Lasher, L.C.; McDaniel, E.W. (Oak Ridge National Lab., TN). pp 785-792 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC05-84OR21400.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

In 1943, six storage tanks were built at the Clinton Laboratories [later to become Oak Ridge National Laboratory (ORNL)] later to contain wastes generated by wartime research and development operations. During the following years, these tanks became an integral part of the ORNL waste system and accumulated ~ 1.5 x 10^6 L (400,000 gal) of sludge containing radioactive wastes. Recently, over a period of ~18 months, these tanks were sluiced, the radioactive sludge resuspended, and the resuspended slurry pumped to the ORNL Hydrofracture Facility for underground disposal. In this paper, a summary of the development work is given, and the process design and constraints are described. the operating difficulties encountered and overcome included grinder blade erosion, malfunctioning instruments, pump section plugging, and slurry settling. About 90% of the settled sludge (containing ~ 715,000 Ci) was removed for the system. 2 refs., 4 figs.

31563 **High-level radioactive insoluble waste preparation for vitrification.** Hamm, B.A.; Eibling, R.E.; Ebra, M.A.; Motyka, T.; Martin, H.D. (Savannah River Lab., Aiken, SC). pp 793-799 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

At the Savannah River Plant (SRP), a process has been developed for immobilizing high-level radioactive waste in a borosilicate glass. The waste is currently stored as soluble salts and insoluble solids. Insoluble waste as stored requires further processing before vitrification is possible. The processes required have been developed and demonstrated with actual waste. They include removal of aluminum in some waste, washing soluble salts out of the insoluble waste, and mercury stripping. Each of the processes and the results with actual SRP waste will be discussed. The benefits of each step will also be included. 3 refs., 3 figs.

31564 **Technetium removal processes for soluble defense high-level waste.** Walker, D.D.; Bibler, J.P.; Wallace, R.M.; Ebra, M.A.; Ryan, J.P. Jr. (Savannah River Lab., Aiken, SC). pp 801-807 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Two methods for removing technetium from soluble defense high-level waste are described. In the first method, technetium is precipitated as tetraphenylphosphonium pertechnetate and separated from the decontaminated solution using sintered metal crossflow filters. In the second method, pertechnetate is removed from solution using a strong base anion exchange resin and then eluted from the resin with nitric acid. The nitric acid is recovered by sorption of the pertechnetate on a weak base ion exchange resin. The pertechnetate is eluted from the weak base resin with NaOH and recovered by precipitation as the sulfide or oxide. 7 refs., 3 figs.

31565 **Improved uranium recovery from the process strams in an electroplating facility.** Pickett, J.S. (Savannah River Lab., Aiken, SC). pp 809-815 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Cylindrical uranium slugs are used as irradiation targets in the production reactors at the Savannah River Plant. These slugs are first chemically etched, nickel plated, encased in aluminum, inspected, and individually pressure tested. An improved process was developed to recover the uranium from the acidic etching streams by controlling pH and the PO_4 to U ratio so that the precipitation of the uranium as hydrogen uranyl phosphate was maximized. Bench-scale tests demonstrated that the recovery of uranium could be increased to greater than 99.9% (vs. the current level of about 95% recovery). The recommended changes involved the addition of process effluent "hold" tanks. The addition of the various process streams to the neutralization/precipitation tank could therefore be controlled to maintain a consistent ratio of uranyl nitrate and phosphoric acid. Also, it was determined that a strong caustic solution (resulting from the dissolution of rejected aluminum slugs) could be utilized to neutalize the nitric and phosphoric acid solu-

tions. The buffering action of the aluminum in the "coustic recovery solution" would reduce the sensitivity of the hydrogen uranyl phosphate precipitation to the phosphate ion concentration. 7 refs., 3 figs.

31566 **Evaluation of materials performance in a large-scale glass melter after two years of vitrifying simulated SRP defense waste.** Iverson, D.C.; Bickford, D.F. (Savannah River Lab., Aiken, SC). pp 839-845 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Large Slurry Fed Melter (LSFM) at the Department of Energy's Savannah River Plant recently completed two years of service and was shut down for evaluation. The melter operating history is reviewed and the condition of the refractories and metal components is described. The excellent condition of the LSMF verifies the expected performance of the materials of construction, and indicates that a two-year melter life is achievable in the Defense Waste Processing Facility (DWPF). 13 refs., 2 figs., 1 tab.

31567 **Source term development for tritium at the Sheffield disposal site.** Mackenzie, D.R.; Barletta, R.E.; Smalley, J.F.; Kempf, C.R.; Davis, R.E. (Brookhaven National Lab., Upton, NY). pp 961-967 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Sheffield low-level radioactive waste disposal site, which ceased operation in 1978, has been the focus of modeling efforts by the NRC for the purpose of predicting long-term site behavior. To provide the NRC with information required for its modeling effort, a study to define the source term for tritium in eight trenches at the Sheffield site has been undertaken. Tritium is of special interest since significant concentrations of the isotope have been found in groundwater samples taken at the site and at locations outside the original site boundary. Previous estimates of tritium site inventory at Sheffield are in wide disagreement. In this study, the tritium inventory in the eight trenches was estimeted by reviewing the radioactive shipping records (RSRs) for waste buried in these trenches. It has been found that the tritium shipped for burial at the site was probably higher than previously estimated. In the eight trenches surveyed, which amount to roughly one half the total volume and activity buried at Sheffield, approximately 2350 Ci of tritium from non-fuel cycle sources were identified. The review of RSRs also formed the basis for obtaining waste package descriptions and for contacting large waste generators to obtain more detailed information regarding their waste packages. As a result of this review and the selected generator contacts, the non-fuel cycle tritium waste was categorized. The tritium releases from each of these waste categories were modeled. The results of this modeling effort are presentd for each of the eight trenches selected. 5 refs., 1 fig.

31568 **Management of uranium mill tailings, low-level waste and hazardous waste.** Fort Collins, CO; Colorado State University (1984). 670p. (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

This book presents the papers given at a symposium which dealt with the development of technology to manage mill tailings, low-level radioactive wastes, and hazardous materials. Topics considered at the symposium included impacts, regulations, contaminant migration, radon control and covers, case studies, remedial action, long-term stability, land reclamation, testing, and sampling.

31569 **Volume reduction of low-level radioactive wastes.** Bryson, H.; Weeter, D.W.; Oakes, T.W. (Dept. of Civil Eng., Univ. of Tennessee, Knoxville, TN 37996). pp 561-565 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

The Biology Division of Oak Ridge National Laboratory (ORNL), located at the Y-12 site of the Oak Ridge Reservation, produces modest amounts of radioactive mixed (radioactive and hazardous) wastes which present unique disposal problems under current Federal (Dept. of Energy (DOE)), Nuclear Regulatory Commission (NRC) and Environmental Protection Agency (EPA) and State of Tennessee rules and regulations governing the disposal of these types of wastes. These wastes fall into five categories, as generated: (a) liquid (laboratory process) wastes, (b) dry (lab trash) wastes, (c) animal carcases. The liquid waste is considered to contain ≃ 90% of the total radioactivity of the wastes. The most feasible long-term method of dealing with these wastes, consists of four inter-related processes. These are (1) distillation of the liquid wastes to remove a volatile, slightly radioactive organic fraction (to be incinerated); (2) scintillation fluid ("cocktail") recovery and component separation; (3) incineration (high temperature, high efficiency) of the relatively low activity dry waste, animal bedding, animal carcasses; and the slightly radioactive (^{3}H and ^{14}C) flammable components from the liquid and scintillation fluid wastes; and (4) cold chemical oxidation and solidification in cement of the aqueous waste fractions from distillation and scintillation fluid separation steps. This alternative provides for the elimination of all hazardous components with the minimum release of radioactivity into the environment. Only a small fraction of the original waste would be landfilled as either immobiled radioactive waste (low activity tritiated water in carbon-14 carbonate and other "institutional" radioisotopes or non-hazardous ash.

31570 **Neutralizing barrier for reducing contaminant migration from a uranium mill tailings disposal pond.** Opitz, B.E.; Sherwood, D.R. (Battelle Pacific Northwest Labs., Richland, WA 99352). pp 93-103 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

Under sponsorship of the Nuclear Regulatory Commission's Uranium Research and Recovery Program, Pacific Northwest Laboratory, (PNL) has investigated the use of various neutralizing reagents and techniques to attenuate the movement of contaminants associated with acidic uranium mill tailings solutions. Results of these investigations have led to the development of a low permeable, neutralizing barrier that may effectively reduce contaminant migration from a tailings impoundment. In terms of contaminating surface or ground water, the waste solution of primary concern is that which escapes the designated waste disposal facility. By incorporating a neutralizing barrier below the tailings pond, the only solution that is treated is that which escapes. Therefore, substantial solution treatment cost savings could result from not having to treat the entire solution within a tailings pond in order to minimize the effects of drainage of acidic uranium mill tailings solution. In laboratory verification tests, a neutralizing barrier reduced the effluent solution concentrations of several constituents (e.g. Al, As, Cr, Fe, V, ^{210}Pb, ^{238}U and ^{230}Th) by greater than 90% in comparison to concentrations found within the pond. Furthermore, the neutralizing barrier inhibited drainage because of its reduced permeability (10^{-8} cm/s).

31571 **Asphalt emulsion radon barrier systems for uranium mill tailings: A summary of the technology.** Baker, E.G.; Hartley, J.N.; Freeman, H.D. (Pacific Northwest Lab., Richland, WA). pp 235-244 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

Pacific Northwest Laboratory (PNL), under contract to the U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action Project (UMTRAP) office, has developed an asphalt emulsion cover system to reduce the release of radon from uranium mill tailings. The system has been field-tested at the tailings site in Grand Junction, Colorado. Results from laboratory and field tests indicate that this system effectively reduces radon release to near-background levels (<2 pCi $m^{-2}s^{-1}$) and has the properties required for long-term effectiveness and stability. Engineering specifications have been developed, and a cost analysis indicates that asphalt emulsion covers are competitive with other cover systems.

31572 **Predicting long-term moisture in earthen covers.** Gee, G.W.; Nielson, K.K.; Rogers, V.C. (Pacific Northwest Lab., Richland, WA). pp 267-276 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

Earthen cover systems will be used to control radon flux levels at most, if not all, uranium mill tailings disposal sites in the USA. The long-term residual moisture in an earthen cover will determine, to a large degree, the effectiveness of the cover for radon control. The cover moisture content is a function of climate, plant cover, soil type and depth to water table. Estimates of long-term moisture content can be made several ways. Simulations, using deterministic water flow models, provide the most complete description, but require the most detailed information, including long-term climate and plant cover changes, which at present have a high degree of uncertainty. Simpler correlations, related to soil type and expected periodic drought conditions, will likely be more practical for estimating long-term saturation to water retention characteristics of the soil and assumes that residual moisture in the entire soil cover will approach the so called "permanent wilting point" (15 bar percentage). The expected residual moisture saturation at permanent wilting, ranges from 0.07 to 0.56 as soil texture varies from sands to clays at typical field densities. Radon diffusion coefficients for soil cover materials range from 5.0E-2 cm^2/s to 5.0E-3 cm^2/s for sands and clays, respectively, at typical field densities. With increased compaction, the residual moisture saturation can increase significantly and radon diffusion coefficients as low as 3.0E-4 cm^2/s have been measured. The optimal soil cover design will likely be a two-layer cover system with at least a 1-meter-thick plant root zone of uncompacted soil over a moistened, tightly compacted fine textured soil. This design concept has been tested successfully at Grand Junction, Colorado.

31573 **Diffusion of radon in candidate soils for covering uranium-mill tailings.** Kalkwarf, D.R.; Silker, W.B. (Pacific Northwest Lab., Richland, WA). pp 297-305 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

Diffusion coefficients were measured for radon in 34 soils that had been identified by uranium mill personnel as candidate soils for covering their tailings piles in order to reduce radon emission. The coefficients referred to diffusion in the total pore space of the soils. They were measured by a steady-state method using soil columns compacted to greater than 80% of their Proctor maximum packing densities, but with moisture contents generally less than would be expected at a tailings site. Three published empirical equations relating diffusion coefficients to soil moisture and porosity were tested with these data. The best fit was obtained with the equation: $D = 0.70 \exp [-4(m\text{-}mP^- + m^5)]$ in which P is the dry porosity of the soil and m is its moisture saturation, e.e. the fraction of pore volume filled with water. This equation was used to extrapolate measured coefficients to values expected at soil-moisture contents representative of tailings sites in the western United States. Extrapolated values for silty sands and clayey sands ranged from 0.004 to 0.06 cm^2/s where w, the weight ratio of water to dry soil, is expected to vary from 0.04 to 0.09. Values for inorganic silts and clays ranged from 0.001 to 0.02 cm^2/s where w is expected to vary from 0.10 to 0.13.

31574 **Sampling and analysis of high-level waste at West Valley.** Rykken, L.E.; Kardos, Z.L.; Wiedemann, L. (West Valley Nuclear Services Co., Inc. West Valley, NY). pp 257-265 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

Three samples of the supernatant in the main waste storage tank at the West Valley site were taken at different depths. Exhaustive chemical and radiological analyses were performed. The sampling was successfully done under several restraints using an air eductor device which could be lowered into the tank through a 200-cm riser opening. An assumption of homogeneity could reasonably be made based on the analytical and other data. Valuable design information was obtained from the analytical work. Inferences regarding the sludge composition could also be made from the supernatant analysis.

31575 **Designing surface covers: an approach to long-term waste site stabilization.** Beedlow, P.A.; Cadwell, L.L.; McShane, M.C. (Battelle Pacific Northwest Laboratories, Richland, WA). pp 311-315 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

The wide range of existing environmental conditions, potential contaminants and available cover materials at waste disposal sites requires site-specific designing of surface covers for effective long-term erosion resistance. This paper presents a systematic approach to designing surface covers for hazardous waste repositories that can be tailored to conditions at any site. The approach consists of three phases: an assessment, during which the degree of required surface protection (erosion potential) is determined; preliminary design that integrates surface cover design with the need to minimize transport of contaminants; and a final design, where the cost and effectiveness of the surface cover are determined.

31576 **A laboratory and field evaluation of the mobility of cobalt-60/EDTA.** Jones, T.L.; Gee, G.W.; Kirkham, R.R.; Swanson, J.L. (Pacific Northwest Laboratory, Richland, WA). pp 331-334 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

We have observed a time and soil type dependence in the ability of the organic complexant EDTA to keep cobalt-60 in solution. Test results indicate that short-term adsorption tests lasting 5 days or less can be misleading. In short-term tests using cobalt-60/EDTA and soil from the Hanford site, low sorption in batch tests and high mobility in column tests were observed. During long-term batch test using cobalt-60/EDTA, the percentage of cobalt remaining in solution decreased from 90% after 7 days to less than 10% after 500 days. In laboratory and field column tests where low water flow rates allowed long contact time, virtually no cobalt movement was observed even though in the field test tritium was transported over 4 meters. Long-term batch tests using cobalt-60/EDTA and soil from Savannah River burial grounds showed that cobalt remainin in solution dropped to 30% of the total cobalt added after 5 days and to less than 1% after 15 days. Batch tests using soil from Oak Ridge burial grounds were less dramatic showing cobalt in solution decreasing from 90% after 5 days to 70% after 35 days. The cobalt-60/EDTA complex appears to be dissociating and leaving uncomplexed cobalt which is readily sorbed. The dissociation seems to be rather complete in Hanford and Savannah River soil but limited in the Oak Ridge soil. The implication to waste management is that the potential for transport of cobalt by EDTA may not be as serious at all burial sites as once thought.

31577 **The WIPP research and development program: providing the technical basis for defense waste disposal.** Hunter, Th.O. (Experimental Programs Division, Sandia National Laboratories, Albuquerque, NM). pp 367-372 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

The Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico, is being developed by the US Department of Energy as a research and development facility to demonstrate the safe disposal of radioactive wastes from the defense programs of the United States. Underground workings are at a depth of 660 in a bedded-salt formation. Site investigations began in the early 1970s and are culminating with the completion of the Site and Preliminary Design Validation (SPDV) program in 1983 in which two shafts and several thousand feet of underground drifts are being constructed. The underground facility will be used for in situ tests and demonstrations that address technical issues associated with the disposal of transuranic and defense high-level wastes (DHLW) in bedded salt. These tests are based on several years of laboratory tests, field tests in mines, and analytical modeling studies. They primarily address repository development in bedded salt, including thermal-structural interactions plugging and sealing, and facility operations; and waste package interactions, including the effects of the waste on local rock salt and the evaluation of waste package materials. In situ testing began in the WIPP with the initiation of the SPDV program in 1981. In 1983, a major series of tests will begin to investigate the response of the rock salt without the use of any radioactivity.

31578 **A comparison of risks due to HLW and SURF repositories in bedded salt.** Chu, M.S.Y.; Ortiz, N.R.; Wahi, K.K. (Sandia National Laboratories, Fuel Cycle Risk Analysis Division, Albuquerque, NM). pp 249-257 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

A methodology was developed to analyze risks from geologic disposal of nuclear wastes. It was applied to estimate the risk due to spent fuel and high-level waste hypothetical repositories in bedded salt. A number of disruptive scenarios were analyzed for each waste type. A comparison between the spent fuel and high-level waste results is presented. The methodology enables one to identify important radionuclides, parameters, and scenarios in terms of their relative contribution to the overall risk or compliance with the proposed EPA Standard.

31579 **Design of a nuclear waste package for emplacement in tuff.** O'Neal, W.C.; Gregg, D.W.; Hockman, J.N.; Revelli, M.A.; Rotman, A.J. (Lawrence Livermore National Laboratory, Livermore, CA). pp 3-10 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

Design, modeling and testing activities are under way at LLNL in the development of high level nuclear waste package designs. In this paper we discuss the geological characteristics affecting design, the 10CFR60 design requirements, conceptual designs, metals for containment barriers, economic analysis, thermal modeling and performance modeling.

31580 **Mineral resource analysis of the proposed site for underground storage of high-level commercial nuclear waste, Hanford, Washington.** Leaming, G.F.; Davis, J.D. (George Leaming Associates, Marana, AZ). pp 235-242 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

Evaluation of known and potential mineral resources of the Hanford Site and vicinity, Washington State, was undertaken as part of a larger program being conducted by the United States Department of of Energy to evaluate the suitability of candidate sites for construction of terminal repositories for high-level nuclear waste. Current mining within 100 km of the Hanford Site is limited to surface-mined diatomaceous earth, sand and gravel, and stone. Occurrences of relatively low-unit-value minerals within 100 km of the candidate site consist of peat, diatomaceous earth, pumicite, quarry rock, and sand and gravel. Such resources are surficial in occurrence and are not concentrated within the Pasco Basin relative to the remainder of the Columbia Plateau. A small, low-pressure natural gas field, in production from 1929 to 1941, is present at the southern edge of the Hanford Site. No other commercial production of fossil fuels has occurred in the area. With the exception of small, low grade gold placers along the Columbia River, no high-unit-value mineral resources are known to occur within 100 km of the candidate site. Economic analysis of the area within 100 km of the candidate site indicates that gross value of known mineral resources and potential, undiscovered natural gas within Columbia River basalts is $470.5 million. Subtraction of estimated exploration, development, production, and wholesale marketing costs from gross value leaves a net value of $33.3 million. Projected net value per area and per capita averages $569/km^2 and $62/current inhabitant. For the remainder of the Columbia Plateau, respective values are $1,195/km^2 or $98/inhabitant. For a mineral-rich state such as New Mexico, comparable net value per area is $17,600/km^2.

31581 **Borehole to borehole geophysical methods applied to investigations of High-Level Waste repository sites.** Ramirez, A.L. (Lawrence Livermore National Laboratory, Livermore, CA). pp 221-226 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

This discussion focuses on the use of borehole to borehole geophysical measurements to detect geological discontinuities in High-Level Waste (HLW) repository sites. The need for these techniques arises from: the requirement that a HLW repository's characteristics and projected performance be known with a high degree of confidence, and the inadequacy of other geophysical methods in mapping fractures. Probing configurations which can be used to characterize HLW sites are described. Results from experiments in which these techniques were applied to problems similar to those expected at repository sites are briefly discussed. The use of a procedure designed to reduce uncertainty associated with all geophysical exploration techniques is proposed; key components of the procedure are defined.

0530 Environmental Aspects

REFER ALSO TO CITATION(S) 31478, 31489, 31491, 31553, 31554, 31555, 31567, 31573, 31603, 32285, 32291, 32293, 32294, 32296, 32297, 32300, 32301, 32302, 32303, 32307, 32315, 32320, 32745, 32760, 32761, 32872, 32891

31582 **(AERE-R—11765) On the equations for the flow of concentrated salt solution through a porous medium.** Lever, D.A.; Jackson, C.P. (UKAEA Atomic Energy Research Establishment, Harwell. Theoretical Physics Div.). Jul 1985. 14p. H.M. Stationery Office, London, price Pound 4.00.

The governing equations are discussed for the flow of salt solution with significant density variations through a porous medium. Equations for mass conservation, salt conservation and momentum conservation are formulated in terms of the mass-averaged velocity and the mass fraction of concentrated salt solution, and the underlying approximations are considered.

31583 **(HW—49008) Dispersion of dissolved material in the Columbia River.** Honstead, J.F. (General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation). 12 Mar 1957. Contract AC06-76RL01350. 16p. NTIS, PC A02. File Number DE86010091.

Data were obtained downstream from a reactor cooling water vischarge structure to permit application to semi-empirical diffusion equations. Ten traverses of the river were made at different distances from the discharge point to collect samples of water and make velocity readings. The cooling water was discharged essentially at a single point in the bottom of the river about 300 feet

from the Plant shore. Approximately 38% of the river flowed between the point of discharge and the Plant shore. The ten traverses sampled were selected to be as nearly normal to the direction of flow of the main current of the river as could be judged visually. They were selected at distances of 950; 1750; 2850; 3590; 6230; 8870; 14,150; 14,430; 24,710; and 29,990 feet from the point of discharge. The cross-sectional shape and measured velocity pattern of each traverse are shown in Figures 1 through 10. The figures are numbered consecutively according to their distance from the discharge point. Velocities were measured with a Gurley, cup-type velocity meter. The data shown are relative concentrations based on a value of 100 ascribed to the concentration of the reactor effluent at the time of discharge to the river. These data have all been corrected for decay. The samples were all collected from a uniform depth of three feet below the surface of the river, it having been previously determined that vertical concentration variations are negligible on the scales used for plotting. The data shown in the attached figures were obtained in a two-day period during which the river flow, and the flow and concentration of discharged effluent remained essentially constant. 10 figs.

31584 **(HW—49465) Chemical effluents technology waste disposal investigations, July, August, September 1956.** Brown, D.J. (ed.). (General Electric Co., Richland, WA (USA). Hanford Atomic Products Operation). 12 Apr 1957. Contract AC06-76RL01350. 15p. NTIS, PC A02. File Number DE86010089.

Quantitative measurements of the hydraulic characteristics of the sediments beneath the 100-K Area and qualitative information deduced from ground-water contours as of October 1955, indicate the water-bearing formations adjacent to the Columbia River between 100-K Area and 100-F Area to be relatively impermeable (transmit water poorly). In contrast to this, those adjacent to the river between 100-F Area and 300 Area are quite permeable and transmit water monitoring effort. The ground water in the vicinity of the 200-East Area shows a rapid buildup of the Purex groundwater mound from the discharge to ground of a three-month total of 552 million gallons of non-radioactive cooling water. The water table during this period rose as much as 5.7 ft to a maximum level of 408.65 ft. Elsewhere, the water level in wells within the area rose above an altitude of 395 ft, indicating that the water table between 200-East and 200-West Area is building up to levels not previously attained. The ground-water mound beneath 200-West Area was considerably altered during the period from substantial changes in disposal practices. The amount of cooling water discharged to the T-Swump has been reduced from an approximate average of 3 mg/d to only 0.1 mg/d, whereas water to the U-swamp and Redox caverns continued at a combined rate averaging about 6 mg/d. As a result, water levels in the northwest part of the area (beneath T-swamp) dropped as much as 6.4 ft: to an altitude of 471.89 ft while levels beneath the southwestern part rose as much as 0.3 ft to an altitude of 475.80 ft. Thus, the previously predominant southeastward gradient within 200-W Area has been changed so that now a north-eastward gradient prevails, tending to route T-Plant second-cycle contaminants toward more permeable zones in the Gable Butte-Gable Mountain Area.

31585 **(IPEN-Pub—66) Far field migration of radionuclides in two dimensional ground water flows though geologic media.** Ting, D.K.S.; Chambre, P. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil); California Univ., Berkeley (USA)). 1985. 26p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702019.

An analytical method to model radionuclide migration in a two dimensional ground water flow through geologic media has been developed and implemented into the computer code UCBNE21. Using this method, the potential hazard to the biosphere posed by the accidental release of radionuclides from a candidate repository site (WIPP) is determined. I-129 and Ra-226 are potentially the most hazardous nuclides in these sites but their discharge into the biosphere will not result in concentrations larger than their maximum permissible concentrations.

31586 **(LA—10575-MS) Joint DOE/NRC field study of tracer migration in the unsaturated zone.** Nyhan, J.; Polzer, W.; Essington, E.; Cokal, E.; Lane, L.; Lopez, E.; Stallings, E.; Walker, R. (Los Alamos National Lab., NM (USA)). Mar 1986. Contract W-7405-ENG-36. 202p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86007861.

The results of a joint DOE/NRC field experiment to evaluate leaching and transport of solutes in a sandy silt backfill used for shallow land burial operations at Los Alamos are presented for steady-state and unsteady-state flow conditions. The migration of iodide, bromide, and lithium through the backfill material is studied as functions of depth and time and they are compared with one another. The bromide and iodide tracer data are used to estimate the diffusion coefficient, the tortuosity factor, and dispersivity. These values are used to calculate effective dispersion coefficients for subsequent analyses of the retardation factor and the distribution coefficient for lithium using least squares procedures. The results of the tracer migration study are discussed relative to challenges facing the waste management community, and chemical transport modeling opportunities are presented for a modeling workshop to be held in FY86.

31587 **(NUREG—1183) Nonradiological groundwater quality at low-level radioactive waste disposal sites.** Goode, D.J. (Central Vermont Public Service Corp., Rutland (USA)). Apr 1986. 236p. NTIS, PC A11/MF A01 - GPO. File Number TI86901409.

The NRC is investigating appropriate regulatory options for disposal of low-level radioactive waste containing nonradiological hazardous constituents, as defined by EPA regulations. Standard EPA/RCRA procedures to determine hazardous organics, metals, indicator parameters, and general water quality are applied to samples from groundwater monitoring wells at two commercial low-level radioactive waste disposal sites. At the Sheffield, IL site (non-operating), several typical organic solvents are identified in elevated concentrations in onsite wells and in an offsite area exhibiting elevated tritium concentrations. At the Barnwell, SC site (operating), only very low concentrations of three organics are found in wells adjacent to disposal units. Hydrocarbons associated with petroleum products are detected at both sites. Hazardous constituents associated with previosuly identified major LLW mixed waste streams, toluene, xylene, chromium, and lead, are at or below detection limits or at background levels in all samples. Review of previously collected data also supports the conclusion that organic solvents are the primary nonradiological contaminants associated with LLW disposal.

31588 **(REG/G—WM-407-4) Methods for estimating radioactive and toxic airborne source terms for uranium milling operations.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Apr 1986. 51p. U.S. Nuclear Regulatory Commission, Washington, D.C.. File Number TI86901296.

Each licensee who processes or refines uranium ores in a milling operation is required by 10 CFR Part 20, "Standards for Protection Against Radiation," to make every reasonable effort to maintain radiation exposures and releases of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable, taking into account the state of technology and the economics of improvements in relationship to benefits to the public health and safety. This draft regulatory guide provides guidance to applicants and licensees in preparing environmental reports and to the NRC staff in reviewing those reports and in preparing environmental impact statements. The guide addresses methods, models, data, and assumptions acceptable to the NRC staff for estimating airborne emissions of radioactive and toxic materials from various steps in uranium milling.

31589 **(RHO-BW-SA—506-P) Probabilistic modeling of radionuclide release at the waste package subsystem boundary of a repository in basalt.** Sagar, B.; Eslinger, P.W.; Baca, R.G. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Mar 1986. Contract AC06-77RL01030. 48p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010454.

Estimation of potential radionuclide releases from the waste package subsystem of a nuclear waste repository is required for two reasons: (1) to judge whether the engineered barrier system complies with the performance regulations prescribed by the US Nuclear Regulatory Commission; and (2) to provide radionuclide source terms needed to predict the isolation performance of the natural barriers (i.e., geologic medium) which must be compared with the US Environmental Protection Agency safety standard. In this paper, a probabilistic approach developed at the Basalt Waste Isolation Project (BWIP), for the estimation of radionuclide releases from a proposed nuclear waste repository in basalt is presented. The central idea of this approach is that uncertainties in both the radionuclide transport parameters and the random nature of container failures impact the estimation of release rates. Details of the method are provided which account for both sources of uncertainty. Sample applications are presented that are based on preliminary data. Briefly, the BWIP methodology consists of (1) a container corrosion model, (2) a model describing the random sequence of container failures in time, (3) a stochastic transport model to obtain the probability distribution of releases from a single container failing at a specified time, and (4) a model to integrate the releases from the randomly failing containers in the repository.

31590 **Solubility limits, on radionuclide dissolution.** Kerrisk, J.F. (Los Alamos National Lab., NM). pp 237-244 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

This paper examines the effects of solubility in limiting dissolution rates of a number of important radionuclides from spent fuel and high-level waste. Two simple dissolution models were used for calculations that would be characteristic of a Yucca Mountain repository. A saturation-limited dissolution model, in which the water flowing through the repository is assumed to be saturated with each waste element, is very conservative in that it overestimates dissolution rates. A diffusion-limited dissolution model, in which element-dissolution rates are limited by diffusion waste elements into water flowing past the waste, is more realistic, but it is subject to some uncertainty at this time. Dissolution rates of some elements (Pu, Am, Sn, Th, Zr, Sm) are always limited by solubility. Dissolution rates of other elements (Cs, Tc, Np, Sr, C, I) are never solubility limited; their release would be limited dissolution of the bulk waste form. Still other elements (U, Cm, Ni, Ra) show solubility-limited dissolution under some conditions. 9 refs., 3 tab.

31591 **NNWSI waste form performance test development.** Bates, J.K.; Gerding, T.J. (Argonne National Laboratory, IL). pp 295-302 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

A test method has been developed to measure the release of radionuclides from the waste package under simulated NNWSI repository conditions, and to provide information concerning materials interactions that may occur in the repository. Data from 13 weeks of unsaturated testing are discussed and compared to that from a 13-week analog test. The data indicate that the waste from test is capable of producing consistent, reproducible results that will be useful in evaluating the role of the waste package in the long-term performance of the repository. 6 refs., 3 figs.

31592 **Sorption-capacity limited retardation of radionuclides transport in water-saturated packing materials.** Pescatore, C.; Sullivan, T. (Brookhaven National Lab., Upton, NY). pp 369-376 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Radionuclides breakthrough times as calculated through constant retardation factors obtained in dilute solutions are non-conservative. The constant retardation approach regards the solid as having infinite sorption capacity throughout the solid. However, as the solid become locally saturated, such as in the proximity of the waste form-packing materials interface, it will exhibit no retardation properties, and transport will take place as if the radionuclides were locally non-reactive. The magnitude of the effect of finite sorption capacity of the packing materials on radionuclide transport is discussed with reference to high-level waste package performance. An example based on literature sorption data indicated that the breakthrough time may be overpredicted by orders of magnitude using a constant retardation factor as compared to using the entire sorption isotherm to obtain a concentration-dependent retardation factor. 8 refs., 3 figs., 3 tabs.

31593 **Transport and capture of colloidal particles in single fractures.** Bonano, E.J.; Beyeler, W.E. (Sandia National Labs., Albuquerque, NM; OAO Corp., Albuquerque, NM). pp 385-392 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC04-76DP00789.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

In this study, the transport and capture rates of colloidal particles were calculated for a parallel-plate channel simulating a single fracture. The steady-state convective diffusion equation was solved with the particle velocity normal to the walls of the channel being the sum of the external forces acting on the particles. The forces considered were the gravitational, London-van der Waals and electric-double layer forces. The effects of parameters governing these forces and particle production mechanism on the rates of particle capture and transport are determined. The dynamic balance between particle production and capture has a significant effect on the concentration of particles leaving the fracture. The average particle velocity, through higher than the average fluid velocity, seems to be insensitive to phenomena governing particle capture. 7 refs., 3 figs.

31594 **Behavior of natural uranium, thorium, and radium isotopes in the Wolfcamp brine aquifers, Palo Duro Basin, Texas.** Laul, J.C.; Smith, M.R.; Hubbard, N. (pacific Northwest Lab., Richland, WA; Battelle Memorial Inst., Columbus, OH). pp 475-482 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Previously reported results for Palo Duro deep brines show that Ra is highly soluble and not retarded. Relative to Ra, U, and Th are highly sorbed. uranium, like thorium, is in the +4 valence state, indicating a reducing environment. Additional data reported here support these results. However, one Wolfcamp brine sample gives somewhat different results. Radium appears to be somewhat sorbed. Uranium is largely in the +6 valence state, indicating a less reducing condition. In all brines, kinetics for sorption (^{228}Th) and desorption (^{224}Ra) are rapid. This Wolfcamp brine was tested for the effects of colloids for Ra, U, and Th concentrations. No effects were found. 7 refs., 4 figs.

31595 **Thermodynamically coupled mass transport processes in a saturated clay.** Carnahan, C.L. (Lawrence Berkeley Lab., CA). pp 491-498 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC03-76SF00098.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Gradients of temperature, pressure, and fluid composition in saturated clays give rise to coupled transport processes (thermal and chemical osmosis, thermal diffusion, ultrafiltration) in addition to the direct processes (advection and diffusion). One-dimension transport of water and a solute in a saturated clay subjected to mild gradients of temperature and pressure was simulated numerically. When full coupling was accounted for, volume flux (specific discharge) was controlled by thermal osmosis and chemical osmosis. The two coupled fluxes were oppositely directed, producing a

point of stagnation within the clay column. Solute flows were dominated by diffusion, chemical osmosis, and thermal osmosis. Chemical osmosis produced a significant flux of solute directed against the gradient of solute concentration; this effect reduced solute concentrations relative to the case without coupling. Predictions of mass transport in clays at nuclear waste repositories could be significantly in error if coupled transport processes are not accounted for. 14 refs., 8 figs.

31596 **Transport code for radiocolloid migration: with an assessment of an actual low-level waste site.** Travis, B.J.; Nuttall, H.E. (Los Alamos National Lab., NM; Nuttall and Associates, Inc., Albuquerque, NM). pp 969-976 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Recently, there is increased concern that radiocolloids may act as a rapid transport mechanism for the release of radionuclides from high-level waste repositories. The role of colloids is, however, controversial because the necessary data and assessment methodology have been limited. To quantitatively assess the role of colloids, the TRACR3D transport code has been enhanced by the addition of the population balance equations. The code was tested against the experimental laboratory column data of Avogadro et al. Next a low-level radioactive waste site was investigated to explore whether colloid migration could account for the unusually rapid transport of plutonium and americium observed. The nature and modeling of radiocolloids are discussed along with site simulation results from the TRACR3D code. 20 refs., 3 figs.

31597 **Groundwater contamination at the inactive Riverton, Wyoming uranium mill tailings.** White, A.F.; Yee, A.; Narasimhan, T.N.; Smith, A. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 185-195 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

Low pH process waters contained in a number of inactive and abandoned uranium mill tailings in the United States represent potential sources of radionuclide and trace metal contamination of ground water. Detailed investigation at a typical site at Riverton, Wyo., U.S.A. indicates chemical transport occurs from initial dewatering of the tailings, downward infiltration due to precipitation, and groundwater intrusion into the base of the tailings pile. Relict contaminant plumes, including sulfate, in the shallow groundwater, indicate past periods of tailing dewatering. Except for elevated uranium and molybdenum concentrations, radionuclide and trace metal transport are limited by near-neutral pH conditions in the groundwater. pH is controlled by neutralization of acid tailings water by soil carbonates. A geochemical mixing model employing the PHREEQE computer code is used to estimate current rates of the ground water contamination by tailings water. Significant reactions are the dissolution of calcite, formation of CO_2 and precipitation of gypsum and iron and aluminum hydroxides. Calculated results indicate a mixing rate of 1.5×10^{-4} $m^3.s^{-1}$ beneath the tailings and an evapotranspiration loss of 1.8×10^{-3} $m^3.s^{-1}$ from the tailings surface.

31598 **Rapid seepage of contaminants through the highwall of a uranium mill tailings pit.** Pin, F.G.; Witten, A.J.; Sharp, R.D.; Long, E.C. (Environmental Impact Section, Energy Div., Oak Ridge National Lab., Oak Ridge, TN). pp 155-165 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

A computer code (MIGRAT) is used to quantify the migration of moisture and multiple retarded contaminants in the unsaturated zone and assess the impact of open mine disposal of uranium mill tailings. The model is applied to a generic uranium mill tailings pit constructed with a clay-lined bottom and steep unlined sidewalls. The migration of a two contaminant system is modeled assuming that neither contaminant decays and only one contaminant is retarded. This study shows the anticipated result that moisture and contamination migrate slowly through the bottom clay liner and that, in this migration, concentrations of the retarded contaminant significantly lag the unretarded contaminant. This study also shows the major pathway from the pit to the underlying water table is through the sidewall and that the time scales for this pathway are much shorter than those associated with the clay liner. More importantly, this study reveals that due to the strong nonlinear character of the hydraulic properties of unsaturated soils, concentrations of the retarded contaminant may only slightly lag the nonretarded contaminant through this pathway and contamination of the uppermost aquifer by the retarded contaminant may occur shortly after contamination by the nonretarded contaminant.

31599 **The effects of crystalline Fe and Mn oxides on contaminant migration through soil liners.** Dodson, M.E.; Gee, G.W.; Serne, R.J. (Pacific Northwest Lab.). pp 125-134 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

Tailings solution, produced from tailings excavated at the Canonsburg, Pennsylvania UMTRAP site, was used in liner material column flow studies to test the attenuation characteristics of local borrow pit soil found adjacent to the tailings area. The effluents from liner columns, under saturated conditions, were sampled at fractional pore volumes and analyzed for macro cation, anion, trace metal and radionuclide contents. Solution displacement was allowed to continue until three pore volumes of tailings solution had contacted the liner material. In addition, two amended liner mixtures were contacted with Canonsburg tailings solution to assess the effects of crystalline iron and manganese oxides in attenuating contaminants. The amended mixes represented Canonsburg soil plus either 2% (dry wt. basis) reagent grade iron oxide or 2% manganese saturated green sand zeolite. Attenuation of most trace metals and radionuclides was high in all three column studies, while macro ions, zinc, and the anions Cl and SO_4 showed limited signs of attenuation regardless of whether the soil was amended or not. In addition, there were no signs of excess leaching of Fe or Mn from the columns enriched with their oxides. General results indicate that the addition of iron and manganese oxides in their crystaline form is of little additional value compared to the attenuation of contaminants achieved with native iron and manganese oxides found as partial coatings on the silicate minerals of the unamended Canonsburg soil.

31600 **Fugitive dust control at uranium mill tailings piles.** Elmore, M.R.; Hartley, J.N. (Pacific Northwest Lab., Richland, WA). pp 51-59 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

Possible wind erosion of the tailings is one concern associated with the disposal of uranium mill tailings. If eroded, the tailings could subsequently deposit on areas outside the impoundment. Pacific Northwest Laboratory (PNL), under contract to the U.S. Nuclear Regulatory Commission (NRC), is investigating various techniques for fugitive dust control at uranium mill tailings piles. This paper presents the results of both laboratory and field studies. The laboratory studies have included wind tunnel testing of 43 commercially available chemical stabilizers. Fifteen of the more promising stabilizers were applied to test plots on a tailings pile at the American Nuclear Corporation-Gas Hills Project mill site, Gas Hills, Wyoming, and were monitored quarterly for about 1 year. Of the stabilizers tested, three synthetic polymer (latex) emulsions were more effective than the other stabilizers: Wallpol 40-133 from Reichold Chemicals, SP-400 from Johnson-March Corporation, and CPB-12 produced by Wen Don Corporation. A summary of ongoing assessments of these chemical stabilizers and an evaluation of the effec-

tiveness and durability of commercial wind screens in reducing fugitive dust on tailings piles are also presented in this paper.

31601 **Mathematical simulation of contaminant distribution in and around the uranium mill tailing piles, Riverton, Wyoming.** Narasimhan, T.N.; Tokunaga, T.; White, A.F.; Smith, A.R. (Earth Sciences Div., Lawrence Berkeley Lab., Berkeley, CA 94720). pp 197-207 of Management of uranium mill tailings, low-level waste and hazardous waste. Fort Collins, CO; Colorado State University (1984). (CONF-840245—).

From 6. symposium on management of uranium mill tailings, low-level waste, and hazardous waste; Ft. Collins, CO, USA (1 Feb 1984).

The ultimate objective of the Uranium Mill Tailings Remedial Action Project (UMTRAP) is to minimize the potential environmental hazards due to the existing inactive uranium mill tailing piles. One of these sites, at Riverton, Wyoming, is located on the flood plain of the Wind River, with the water table lying within a few meters of the bottom of the tailings. Field data clearly indicates that contaminants, both radioactive and non-radioactive, are mobile within the tailings as well as in the adjacent ground water system. From the point of view of remedial action, the following important questions arise: At what rates and quantities will the contaminants continue to migrate in the ground water system over the next several hundred years? What will be the soil-water regime in the upper part of the tailings which controls the migration of radon gas to the atmosphere? In view of the projected system behavior, what are the economically viable and environmentally acceptable engineering solutions for remedy? The purpose of the mathematical modeling efforts at the Riverton site is to address the question of prediction; the transport of contaminants in the ground water system as well as the dynamic soil-water regime near the upper boundary. The use of mathematical models for the above purpose is dictated by the following questions: Do adequate computational models exist that can simulate the physico-chemical processes that characterize the mill tailings? Can these models reasonably explain the chemical evolution of the system since the beginning of the tailings emplacement? If so, can the historical behavior be used as the basis for predicting the behavior over the next several hundred years?

31602 **Radionuclide distributions around a low-level radioactive waste disposal pond and ditch system at the Hanford Site.** Last, G.V. (Rockwell Hanford Operations, Richland, WA). pp 323-330 of Waste management '83. Vol. 2. La Grange Park, IL; American Nuclear Society (1983). (CONF-830205—).

From Waste management conference; Tucson, AZ, USA (27 Feb 1983).

Chemical reprocessing of spent nuclear fuels at the U.S. Department of Energy (DOE) Hanford Site has generated large volumes of low-level radioactive liquid effluents. The majority of these effluents have been used strictly for cooling or other support functions and have been discharged to ditches and ponds. The 216-U-10 (U) Pond and 216-Z-19 (Z-19) Ditch are two such disposal facilities and were selected as representative examples of the surface liquid disposal facilities used at the Hanford Site. These facilities are components of an integrated system of ditches, ponds, and overflow facilities collectively referred to as the U Pond disposal system. The U Pond system has been used since 1943 and has received a large variety of radioisotopes from several sources. The long-term use of U Pond and Z-19 Ditch has resulted in the localized accumulation of transuranic and fission product inventories due to sorption and filtration of particulates onto the uppermost sediments. The various radionuclides have different distributions due to their individual discharge sources and behaviors in this type of a disposal system. Cesium-137 is the most widely distributed radionuclide and was used as an index radionuclide to define the maximum extent of contamination. Its 400 pCi/g isopleth indicates surface contamination of approximately 19 hectares at U Pond and the 216-U-11 Overflow Basin. This contamination is localized in the top 10 cm of soil and decreases rapidly with depth. The Z-19 Ditch and its backfilled predecessors, the 216-Z-11 (Z-11) and 216-Z-1 (Z-1) Ditches, received Plutonium-238/239/240 and Americium-241 discharges from the 234-5Z and 231-Z facilities and retained more than 90% of the plutonium inventory discharged to the U Pond system. Based upon the results of this study, the U Pond system has been found to be an effective waste management facility for disposing of large volumes of low-level liquid wastes.

0540 Health And Safety

REFER ALSO TO CITATION(S) 31482, 31489, 31571, 31589, 31601, 32506, 32761, 32850

31603 **(DOE/OR/20722—100) St. Louis Airport Site annual site environmental report. Calendar year 1985.** (Bechtel National, Inc., Oak Ridge, TN (USA). Advanced Technology Div.). Apr 1986. Contract AC05-81OR20722. 55p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86009877.

During 1985, the environmental monitoring program was continued at the St. Louis Airport Site (SLAPS) in St. Louis County, Missouri. The ditches north and south of the site have been designated for cleanup as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a United States Department of Energy (DOE) program to identify, decontaminate, or otherwise control sites where low-level radioactive contamination remains from the early years of the nation's atomic energy program. The site is not currently controlled or regulated by DOE or NRC, although radiological monitoring of the site has been authorized by the DOE. The monitoring program at the SLAPS measures radon gas concentrations in air; external gamma radiation dose rates; and uranium, thorium, and radium concentrations in surface water, groundwater, and sediment. Potential radiation doses to the public are also calculated. Because the site is not controlled or regulated by the DOE, the DOE Derived Concentration Guides (DCGs) are not applicable to SLAPS, but are included as a basis for comparison only. The DOE DCGs and the DOE radiation protection standard have been revised.

31604 **(K/P—6197-Rev.1) Investigation of a uranium hexafluoride release incident on September 17, 1975 in the K-1423 Toll Enrichment Facility (U). Revision 1.** (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 16 Apr 1986. Contract AC05-84OT21400. 79p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86009328.

An explosion occurred in a 30A 2-1/2 ton UF_6 cylinder at the K-1423 Toll Enrichment Facility on September 17, 1975, cracking the cylinder and resulting in the release of about 18 lb of UF_6. The damaged cylinder was one of 10 cylinders received by ORGDP from an enriching service customer on March 19, 1975. These cylinders were cleaned and inspected at ORGDP, returned to the cylinder manufacturer for inspection and hydrostatic testing, then reinspected at ORGDP, valves installed and leak tested, and evacuated prior to filling with enriched UF_6 at the Toll Enrichment Facility. A committee was appointed to determine the cause of the incident, thoroughly evaluate procedures and practices and recommend necessary changes to preclude recurrence of a similar incident in the future. This report presents the investigations carried out by the committee and their conclusions and recommendations based on findings.

31605 **(NUREG/CR—4319) NUCRAC: a code for the estimation of adversary-action consequences in the nuclear power fuel cycle.** Kaul, D.C.; Ritzman, R.L.; Roberts, J.A.; Sachs, E.S. (Science Applications International Corp., Schaumburg, IL (USA)). Feb 1986. Contract AC02-76CH00016. 433p. (BNL-NUREG—51904). NTIS, PC A19/MF A01 - GPO. File Number TI86009630.

A program sponsored by the Nuclear Regulatory Commission (NRC) and designed to estimate the potential consequences of adversary actions in the nuclear power fuel cycle has been completed. So that the results of this consequence analysis would be comparable to that of the reactor Safety Study (RSS), the methodology described in the RSS and implemented in the Calculation of Reactor Accident Consequences (CRAC) code served as the baseline for consequence evaluation in this study. Four portions of the RSS methodology were modified for use in this study: the atmospheric dispersion model, the inhalation dose factors, the criterion for early mortality from lung dose, and the model for chronic pathways to man. Implementation of these modifications to the CRAC code re-

sulted in the preparation and application of a revised code termed NUCRAC. These modifications are described in detail. Detailed instructions for the operation of NUCRAC are presented in the form of a user manual. Inputs and outputs for an example calculation are also presented.

31606 **(NUREG/CR—4561) FIRAC User's Manual: a Computer code to simulate fire accidents in nuclear facilities.** Nichols, B.D.; Gregory, W.S. (Los Alamos National Lab., NM (USA)). Apr 1986. Contract W-7405-ENG-36. 308p. (LA—10678-M). NTIS, PC A14/MF A01 - GPO. File Number TI86010227.

This user's manual supports the fire accident analysis computer code FIRAC. FIRAC is designed to estimate radioactive and nonradioactive source terms and to predict fire-induced flows and thermal and material transport within the ventilation systems of nuclear fuel cycle facilities. FIRAC has been expanded and modified to include the capabilities of the zone-type compartment fire model computer code FIRIN developed by Battelle Pacific Northwest Laboratories. The two codes have been coupled to provide an improved simulation of a fire-induced transient within a facility. The basic material transport capability of FIRAC has been retained and includes estimates of entrainment, convection, deposition, and filtration of material. Also, the interrelated effects of filter plugging, heat transfer, gas dynamics, material transport, and fire and radioactive source terms are simulated. This report summarizes the physical models that describe the gas dynamic, material transport, heat transfer, and source term processes and illustrates how a typical facility is modeled using the code. The modifications required to couple the code to FIRIN also are presented. Finally, the input and code-calculated output for several sample problems that illustrate some of the capabilities of the code are described.

31607 **(UCRL—53696) Joint research and development and exchange of technology on toxic material emergency response between LLNL and ENEA. 1985 progress report.** Dickerson, M.H.; Caracciolo, R. (Lawrence Livermore National Lab., CA (USA); ENEA, Rome (Italy)). 31 Jan 1986. Contract W-7405-ENG-48. 25p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86009552.

For the past six years, the US Department of Energy, LLNL, and the ENEA, Rome, Italy, have participated in cooperative studies for improving a systems approach to an emergency response following nuclear accidents. Technology exchange between LLNL and the ENEA was initially confined to the development, application, and evaluation of atmospheric transport and diffusion models. With the emergence of compatible hardware configurations between LLNL and ENEA, exchanges of technology and ideas for improving the development and implementation of systems are beginning to emerge. This report describes cooperative work that has occurred during the past three years, the present state of each system, and recommendations for future exchanges of technology.

31608 **Probabilistic analysis of human intrusion in a high level nuclear waste repository in salt using draft EPA assumptions.** Harper, W.V.; Raines, G.E. (Battelle Memorial Inst., Columbus, OH). pp 499-506 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Office of Nuclear Waste Isolation (ONWI) has planned performance assessments that will quantify various performance measures for the eventual licensing of a repository in salt. In addition to studying "expected" conditions, selected discrete event scenarios must be analyzed. This paper presents a probabilistic analysis of a human intrusion scenario in which boreholes may be drilled into the repository, contact nuclear waste, and release the radionuclides to the environment. A stochastic analysis using draft EPA limiting factors regarding probability of drilling and quantities of water flow is compared to the proposed EPA 10,000 year limits. The years in which boreholes penetrate the repository are probabilistically determined in each iteration of the analysis. For each borehole, the probability of contacting radioactivity is an increasing function of time. When a borehole does make contact with radioactivity, the curie release of a given nuclide is a function of solubility limits and current inventory. Prediction intervals and complementary cumulative probability distribution functions are developed for the curie release as a fraction of the EPA limits. Radionuclide releases are small fractions of the EPA limits. This study shows that there is a high expectation that the EPA requirements would be met with a repository in salt. 6 refs., 4 figs., 2 tabs.

0550 Regulations

REFER ALSO TO CITATION(S) 31588

31609 **(INIS-BR—467) Impasses and mistakes of the nuclear non-proliferation policy.** Hirst, M. (International Atomic Energy Agency, Vienna (Austria)). 1980. 19p. (In Portuguese). (CONF-8010385—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702100.

From 4. annual meeting of the National Association in Social Science Research; Rio de Janeiro, Brazil (29 Oct 1980).

It is analyzed the limitations for implementing the American Nuclear non-proliferation policy. It is shown the crisis of the North American international relations, with the economic and scientific development of the advanced capitalist nations and some countries of the third world, the penetration of these countries in the world trade commerce of the nuclear industry as sellers and consumers, and the Latin American's and Brazil's position in the international panorama of nuclear power.

31610 **(INIS-mf—10134) 19335 - Royal Decree 1611/1985 of 17 July amending Royal Decree 2967/1979 of 7 December on the reorganization of activities in the nuclear fuel cycle.** (International Atomic Energy Agency, Vienna (Austria)). 11 Sep 1985. 2p. (In Spanish). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702099.

Published in Boletin Official del Estado No. 218.

Based on the directives given in the National Energy Plan of 1983, this Decree provides that the National Uranium Undertaking (ENUSA) which must constitute a stockpile of nuclear fuels to meet the needs of Spanish nuclear power plants, should now keep a lower stock. Therefore, the contingency stock is to be reduced progressively and a so-called operating stock is to be kept by ENUSA. In addition, the safety stocks of uranium concentrates and uranium enrichment services ensured by ENUSA will be eliminated and replaced by safety stocks or fuel elements in operating power plants to guarantee them a measure of autonomy.

31611 **(IPEN-Pub—70) Application of titrimetric method in the determination of uranium.** Cantagallo, M.I.C.; Rodrigues, C. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 8p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701998.

The analysis of nuclear materials are carried out by Davies-Gray titration. This procedure is evaluated by 'Safeguards Analytical Laboratory - IAEA' for application in material safeguards. The purpose of this paper is in evaluating the precision and accuracy of the analysis carried out in laboratory by participation in 'IAEA' - Analytical Control Service Program'. The samples SR-50 and SR-60 are analysed and the analytical results, the precision and accuracy are presented and discussed.

31612 **(LA—10695-MS) Physical inventory verification exercise at a light-water reactor facility.** Bosler, G.E.; Menlove, H.O.; Halbig, J.K.; Nicholson, N.; Cowder, L.; Ikonomou, P.; Luoma, J.D.; Wilkerson, W.S.; Arvanitakis, H.; Tropasso, R. (Los Alamos National Lab., NM (USA)). Apr 1986. Contract W-7405-ENG-36. 139p. (ISPO—248). NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86008807.

A simulated physical inventory verification exercise was performed at the Three Mile Island (TMI) Unit 1 reactor. Inspectors from the Internatinal Atomic Energy Agency made measurements on fresh- and spent-fuel assemblies and verified the special nuclear material inventory at TMI. Simulated inspection log sheets and computerized inspection reports were prepared.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

REFER ALSO TO CITATION(S) 32362, 33430, 33431, 33432, 33435

31613 **(BARC—1232) Material compatibility studies for Heavy Water Project, Kota.** Abubacker, K.M.; Mehta, C.T.; Pillai, B.P.; Dalvi, M.S.; Kini, R.A. (Bhabha Atomic Research Centre, Bombay (India); Bhabha Atomic Research Centre, Bombay (India). Heavy Water Div.). 1984. 7p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702031.

Technical evaluation of indigenously available proprietary formulations for their suitability as corrosion inhibitors, antifoulants, algaecides, coagulants etc. has been carried out, with a view to find the best combination for use in cooling water systems in Heavy Water Project, Kota. Material compatibility experiments were carried out through laboratory experiments as well as a larger 200 litre test assembly, simulating plant conditions and appropriate recommendations were made to the users.

31614 **(BARC—1254) Corrosion inhibitors for carbon steel surfaces in contact with fresh water.** Abubacker, K.M.; Mehta, C.T.; Pillai, B.P. (Bhabha Atomic Research Centre, Bombay (India)). 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702014.

Technical evaluation of indigenously available proprietary formulations as well as some non-proprietary chemicals such as phosphates, silicates, borax, benzoic acid, amines, amino-methylene phosphonates etc. have been carried out, with a view to find the best combination for use in cooling water systems of the Heavy Water Projects of the Department of Atomic Energy. Material compatibility experiments were carried out through laboratory experiments as well as small 10 litre capacity test assembly simulating plant conditions.

0702 Radiation Sources

31615 **(INIS-mf—10123) 16 July 1985: Royal Order amending the Royal Order of 24 April 1964 on approval of a certain type of apparatus containing radioactive substances, made in implementation of Section 3.1.d/2 of the Royal Order of 28 February 1963 enacting General Regulations for Protection of the Population and Workers against the Hazards of Ionizing Radiation.** (International Atomic Energy Agency, Vienna (Austria)). 18 Sep 1985. 2p. (In French and Dutch). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702087.

Published in Moniteur Belge.

The amendments made by this Order mainly concern additional information to be supplied in the context of the approval procedure for certain types of devices containing radioactive substances which are in current use.

31616 **(INIS-mf—10130) SI 1985 No. 1047 - The Radioactive Substances (Gaseous Tritium Light Devices) Exemption Order 1985.** (International Atomic Energy Agency, Vienna (Austria)). 8 Jul 1985. 6p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702088.

This Order which came into force on 17 September 1985 is concerned with exemptions and exclusions under the Radioactive Substances Act 1960 in respect of articles containing tritium gas.

31617 **(INIS-mf—10131) SI 1985 No. 1048 - The Radioactive Substances (Luminous Articles) Exemption Order 1985.** (International Atomic Energy Agency, Vienna (Austria)). 8 Jul 1985. 5p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702089.

This Order, which came into force on 17 September 1985, is concerned with exemptions and exclusions under the Radioactive Substances Act 1960 in respect of radioactive luminous instruments and indicators.

31618 **(INIS-mf—10132) SI 1985 No. 1049 - The Radioactive Substances (Testing Instruments) Exemption Order 1985.** (International Atomic Energy Agency, Vienna (Austria)). 8 Jul 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702090.

This Order, which came into force on 17 September 1985, is concerned with exemptions and exclusions under the Radioactive Substances Act 1960 in respect of testing instruments and radioactive sources used in conjunction with such instruments.

31619 **Radionuclide and electric accelerator sources for food irradiation.** Lagunas-Solar, M.C.; Matthews, S.M. (California Univ., Davis, USA. Crocker Nuclear Lab.; California Univ., Livermore, USA. Lawrence Livermore National Lab.). *Radiation Physics and Chemistry;* **25**: No. 4-6, 691-702(1985). (CONF-8410183—).

From 5. international meeting on radiation processing; San Diego, CA, USA (21 Oct 1984).

Radiation processing of food requires radiation sources with high intensity, penetrability, reliability, and the flexibility to be adapted to current food processing techniques. Current proposed regulations limit the radiation sources which can be utilized to radionuclides or electrically-driven accelerators. Therefore, the power, throughput, and use efficiency of these sources are important factors affecting the design, installation, operation, and economics of large-scale food-processing facilities. An analysis of the advantages and disadvantages of these sources is presented here, with special attention to the current status of both technologies, and with emphasis on the needs of the food-processing industry.

31620 **Comparative economic factors on the use of radionuclide or electrical sources for food processing with ionizing radiation.** Lagunas-Solar, M.C.; Matthews, S.M. (California Univ., Davis, USA. Crocker Nuclear Lab.; Lawrence Livermore National Lab., CA, USA). *Radiation Physics and Chemistry;* **25**: No. 1-3, 111-124(1985). (CONF-8410183—).

From 5. international meeting on radiation processing; San Diego, CA, USA (21 Oct 1984).

Food irradiation is a promising addition to conventional food processing techniques. However, as is the case with most new technologies, its economic suitability will be determined by comparison to current methods. Assuming that current food processing facilities are adaptable to the incorporation of a food irradiation capability, an analysis of cost for several different optional systems able to process up to 100 Mrad ton/day (1 MGy ton/day; or 1,000 ton/day at 100 krad) will be made. Both radionuclide and electrical accelerators will be compared as sources of ionizing radiation. The cost of irradiation will be shown to be competitive with most other treatments including fumigation, low-temperature storage, and controlled atmosphere. A proper figure-of-merit for comparing the different sources will be defined and used as a basis for an economic evaluation of food irradiation.

08 Hydrogen

REFER ALSO TO CITATION(S) 32156

0801 Production

REFER ALSO TO CITATION(S) 31469, 32376

0808 Properties

REFER ALSO TO CITATION(S) 31336

09 OTHER SYNTHETIC AND NATURAL FUELS

0901 Hydrocarbon Fuels

REFER ALSO TO CITATION(S) 31318, 31659, 31663, 31698, 32389, 32797

31621 (ANL/CNSV-TM—167, pp 1-14) **Development of ideas on the nature and agents of biomethanogenesis.** Hungate, R.E. (Univ. of California, Davis). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

An overview is presented on the development of anaerobic digestion and the isolation and culture of methanogenic bacteria, starting with the report of combustible gas arising from a pond in Italy in 1768. The contributions of many scientists from many countries are noted in this discussion of the mechanisms, microorganisms, microbiology, and biochemistry of methanogenesis. 46 references.

31622 (ANL/CNSV-TM—167, pp 15-34) **Acetate metabolism by Methanosarcina.** Krzycki, J.A.; Zeikus, J.G. (Univ. of Wisconsin, Madison). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Acetate metabolism is a key process in methanogens. Methanosarcina barkeri forms methane by the following reactions during growth on acetate as energy source: $CH_3COOH \rightarrow CH_4 + CO_2$. In addition, acetate or an acetyl derivative is synthesized as an early cell carbon precursor by M. barkeri growing on one carbon compounds. Both biodegradation and synthesis of acetate appear to share common biochemical features such as the involvement of methyl-CoM, methyl-B_{12}, and the enzyme carbon monoxide dehydrogenase. Methanogenesis from acetate occurs via two mechanisms; a primary route where methane is derived from an intact methyl group, and a secondary pathway where methane is formed by coupling methyl group oxidation to the reduction of the carboxyl group. A unifying hypothesis for ATP synthesis during methanogenesis from acetate by the primary route is proposed and is based on information obtained from the substrate dependent regulation of carbon monoxide dehydrogenase activity, characterization of the purified enzyme, and analysis of methane production from acetate in cell-free extracts. The hypothesis suggests that an acetyl derivative is metabolized to methyl-CoM and a carbonyl intermediate. The latter is oxidized to CO_2 by carbon monoxide dehydrogenase. The electrons produced are transferred along a membrane bound electron transport chain and used to reduce methyl-CoM to methane. ATP synthesis is then coupled to the free energy of the resultant proton motive force. 68 references, 3 figures, 3 tables.

31623 (ANL/CNSV-TM—167, pp 35-39) **Acetoclastic methanogens in anaerobic digesters.** Touzel, J.P.; Albagnac, G. (Institut National de la Recherche Agronomique, Villeneuve D'Ascq, France). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Methane bacteria able to convert acetate into methane (acetoclastic reaction) play a major role in anaerobic digesters where acetate accounts for more than 2/3 of the methane produced. The first acetoclastic methanogen ever obtained in pure culture was Methanosarcina barkeri. Since sarcina-like organisms were seldom observed in such ecosystems the purification and the isolation of new strains was of interest. Four different strains of methane bacteria converting acetate into methane have been isolated from anaerobic digesters. Some of their main characteristics are presented. 7 references, 2 tables.

31624 (ANL/CNSV-TM—167, pp 41-51) **Metabolism of H_2 and CO_2 by Methanobacterium.** Schoenheit, P.; Thauer, R.K. (Philipps-Universitaet, Marburg, West Germany). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Methanobacterium species grow on H_2 and CO_2 as sole energy source: $4\ H_2 + CO_2 \rightarrow CH_4 + 2\ H_2$. Per mole of methane formed from CO_2 about 1 mol of ATP is generated. Coupling is probably via the chemiosmotic mechanism. The reduction of CO_2 to methane proceeds via carrier bound intermediates involving methanofuran, tetrahydromethanopterin, CoM, component B, and a nickel porphinoid as coenzymes. Most methanobacteria can grow on CO_2 as sole carbon source; i.e., they are autotrophs. Acetyl-CoA rather than 3-phosphoglycerate has been identified as an early CO^2 fixation product. Evidence has accumulated that acetyl-CoA is formed in a carbonylation reaction with a methyl-corrinoid and an acetyl-corrinoid as intermediates. 69 references, 3 figures.

31625 (ANL/CNSV-TM—167, pp 53-66) **Effect of hydrogen concentration on population distribution and kinetics in methanogenesis of propionate.** McCarty, P.L.; Smith, D. (Stanford Univ., CA). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The recent recognition of the significance of acetogenic dehydrogenation as a major stage in methanogenesis of complex substrates has led to questions about current understanding of bacterial growth and the kinetics of substrate utilization. As indicated by the presented evaluation of propionate utilization in methanogenesis, the complexity of the ecology that results from separate hydrogen production and utilization within the system requires a new approach to modeling these complex systems. Important to recognize is the effect of hydrogen partial pressure on the yields of the different bacterial species involved. Also, better information is needed on the substrate affinity of the hydrogen utilizing methanogens because of the significance this has on the effective partial pressure of hydrogen in the system. These are important avenues for further exploration in this interesting and important ecological system. 24 references, 6 figures, 1 table.

31626 (ANL/CNSV-TM—167, pp 67-83) **Energetics of H_2-producing syntrophic bacteria.** Beaty, P.S.; McInerney, M.J.; Wofford, N.Q. (Univ. of Oklahoma, Norman). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—). Contract AS05-83ER13053.

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The complete anaerobic degradation of organic matter to CO_2 and CH_4 requires the concerted action of four major metabolic groups of bacteria. Fermentative bacteria hydrolyze the substrate polymers and ferment the products to volatile acids, CO_2 and H_2. The H_2- and acetate-producing syntrophic bacteria degrade propionate and longer-chain fatty acids and some aromatic acids to acetate, CO_2 and H_2. The acetogenic bacteria produce acetate and sometimes butyrate from H_2/CO_2, CO, CH_3OH and methyoxy moieties of aromatic compounds. Finally, the methanogens use the H_2 produced by the other groups to reduce CO_2 and CH_4, and some species cleave acetate to CH_4 and CO_2. Little is known about the physiology of the H_2- and acetate-producing syntrophs. These bacteria grow very slowly and only grow in coculture with H_2-using bacteria. Methods have been developed to mass-culture Syntrophomonas wolfei in coculture with Methanospirillum hungatei and to obtain cell-free extracts of S. wolfei with minimal contamination from cellular components of the methanogen by lysozyme treatment. S. wolfei extracts contained high specific activities of the β-oxidation enzymes indicating that fatty acids are degraded by this

pathway. Theoretical calculations indicate that end-product excretion may be an important route for energy production in this organism. 26 references, 4 figures, 2 tables.

31627 (ANL/CNSV-TM—167, pp 85-96) **Thermodynamics of catabolic reactions in the anaerobic digestor.** Boone, D.R. (Univ. of California, Los Angeles). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Anaerobic digestion of organic matter takes place in a stepwise manner with interacting physiological groups of organisms which catalyze successive reactions. The products of one reaction are the substrates for the next, and consequently concentration of any intermediate depends on a balance between its rate of production and rate of degradation. Inefficient degradation of a given fermentation product by subsequent metabolic groups causes that product to accumulate. Elevated concentrations of the product, for instance a fermentation acid, may make its formation relatively less favorable, and other fermentation reactions gain preference. Molecular hydrogen is an important intermediate in this respect; because of its low concentration in digestors it has a very rapid turnover, and its concentration changes rapidly and drastically with small changes in the rate of its production or removal. Hydrogen is an important intermediate in other respects as well: it is a product of many different fermentations, and is the precursor to about 30% of the methane formed in anaerobic digestors. Where hydrogen production is rapid and localized, for instance in organic particles, it may accumulate and inhibit hydrogen-producing reactions. Measurement of hydrogen in digestor systems may not reflect this type of concentration gradient. 6 figures.

31628 (ANL/CNSV-TM—167, pp 97-111) **Link between hydrogen and sulfur metabolisms in Methanosarcina barkeri (DSM 800).** Fauque, G.; Teixeira, M.; Moura, I.; Lino, A.R.; Lespinat, P.A.; Xavier, A.V.; Dervartanian, D.V.; Peck, H.D. Jr.; Legall, J.; Moura, J.J.G. (CEN-Cadarache, Saint-Paul Lez Durance, France). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The hydrogenase of the acetoclastic methanogenic bacterium Methanosarcina (M.) barkeri strain DSM 800 grown on methanol has been purified to homogeneity. This soluble hydrogenase has a high molecular weight (800 kDa) and a final specific activity of 270 μmoles of H_2 evolved per min. per mg of protein. It shows an absorption spectrum typical of a non-heme iron protein with a ratio A400/A275 = 0.29. It contains 8-10 iron atoms, 0.6-0.8 nickel atoms and 1 FMN per subunit of molecular weight of 50 kDa. Under hydrogen the purified hydrogenase can reduce the F_{430} cofactor (either free or protein-bound) and the ferredoxin isolated from M. barkeri as well as cytochromes c_{553} and c_3 from Desulfovibrio and c_7 from Desulfuromonas. M. barkeri presents also sulfite, thiosulfate and trithionate reductases activities. The M. barkeri sulfite reductase has been isolated (P_{580}); it contains 0.9 moles of sirohaem and 4.9 g atom of iron per subunit of molecular weight = 23 KDa. The EPR spectrum of P_{580} exhibits characteristics of low spin ferrihaem with g values at 2.40, 2.30 and 1.88. 31 references, 3 figures, 3 tables.

31629 (ANL/CNSV-TM—167, pp 113-123) **Assimilatory reduction of N_2 and NO_3^- by Methanococcus thermolithotrophicus.** Belay, N.; Sparling, R.; Daniels, L. (Univ. of Iowa, Iowa City). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Methanococcus thermolithotrophicus growing on formate as an energy source used dinitrogen (N_2) as the nitrogen source, as evidenced by increase in culture turbidity, protein concentration and methanogenesis. No growth occurred in control cultures lacking N_2 or added NH_4^+. Acetylene reduction assays for nitrogenase using 0.3% acetylene with cells that were producing methane from formate under N_2-fixing conditions showed the production of ethylene; cells grown on NH_4^+ as the nitrogen source did not reduce acetylene. Mc. thermolithotrophicus also grew using NO_3^- as the nitrogen source. This organism is the first methanogen, archaebacterium or thermophile growing above 60°C that has been demonstrated to carry out dinitrogen fixation. 16 references, 2 figures, 1 table.

31630 (ANL/CNSV-TM—167, pp 125-139) **Defined starter culture for biomethanation of proteinaceous wastes.** Jain, M.K.; Zeikus, J.G. (Univ. of Wisconsin, Madison). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

A stable, defined mixed culture was developed which readily degraded gelatin and other proteins into methane and carbon dioxide. The mixture comprised of Methanosarcina barkeri and a novel proteolytic, hydrogen consuming acetogen, Clostridium proteolyticum sp. nov. C. proteolyticum was isolated from a sewage digestor as a prevalent hydrolytic species and its general cellular, growth and metabolic properties are described here. In mono-culture, C. proteolyticum produced both protease and collagenase activity and fermented all the amino acids in gelatin, except proline, into acetate and carbon dioxide as the main products with hydrogen, isovalerate and isobutyrate detected in trace products (< 1 mM). In co-culture with M. barkeri, gelatin was completely hydrolyzed and transformed into methane and carbon dioxide with varying levels of intermediary acetate formed as a function of incubation time. The data show that complex proteinaceous polymers can be readily transformed into methane and carbon dioxide at 30-40°C by a stable coculture which does not require exogenous growth factor additions. In addition, the co-culture was readily transferable and methanogenesis initiated rapidly without the need for exogenous pH control. 26 references, 4 figures, 4 tables.

31631 (ANL/CNSV-TM—167, pp 195-221) **Nutrient requirements for anaerobic digestion.** Speece, R.E.; Parkin, G.F. (Drexel Univ., Philadelphia, PA). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Wastewater sludges generally have been assumed to inherently provide all possible nutrients required for the growth of all members of the microbial ecosystem responsible for anaerobic digestion. However, malfunctioning of the digestion process has been reported. There is evidence that present design and operational practices may have been forged by existing nutrient bioavailability limitations within domestic wastewater sludges. As a case in point, stimulation of the acetate and propionate utilization rate by up to 100% over a control was observed in eight out of thirty municipal sludge digester samples supplemented with one or more of the trace metals iron, cobalt, and/or nickel. A second case in point is that iron supplementation to a municipal sludge digested having a chronically high volatile acids concentration of about 4000 mg/l, resulted in a reduction to 400 mg/l within ten days. Municipal solid wastes are less nutritionally balanced than domestic wastewater sludges. Therefore, even more consideration must be given to assure that nutrient bioavailability is not limiting the overall process of anaerobic digestion of municipal wastes. Major emphasis will be given to bioavailability of trace metals and sulfide in the anaerobic environment and the tight ecological niche which allows mutual bioavailability of mutually precipitating ions. 58 references, 7 figures.

31632 (ANL/CNSV-TM—167, pp 223-233) **Propionate conversion to butyrate in an anaerobic digester.** Samain, E.; Moletta, R.; Dubourguier, H.C.; Albagnac, G. (Institut National de la Recherche Agronomique, Villeneuve D'Ascq, France). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

During batch degradation of propionate by anaerobic sludge or by a highly purified culture, a transient accumulation of acetate and butyrate was observed. Labelling experiments and inhibition of methanogenesis by bromoethane sulfonic acid evidenced that butyrate is a facultative electron sink during acetogenesis rather than an end-product of acetate fermentation by butyric bacteria. 9 references, 6 figures, 1 table.

31633 (ANL/CNSV-TM—167, pp 235-246) **Effects of the addition of propionate and butyrate to thermophilic methane-producing digesters.** Henson, J.M.; Bordeaux, F.M.; Smith, P.H. (Univ. of Florida, Gainesville). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The effects of increased levels of propionate and butyrate on thermophilic bench-top digesters were studied by continuous infusion of these fatty acids, in addition to the regular daily feed, into 3.6 liter digesters. When butyrate was added at the rate of 10 μmol/ml sludge per day, it did not accumulate. The production of biogas (methane and carbon dioxide) increased by 150%. Percent methane in the biogas increased from 56% to 63%. Acetate and propionate concentrations in the sludge increased from 4 to 35 μmol/ml and 0.5 to 3.3 μmol/ml, respectively. When the addition of butyrate was increased to 15 μmol/ml sludge per day, digestion remained stable with elevated concentrations of acetate (150 μmol/ml sludge) and propionate (25 μmol/ml sludge). Daily production of methane was 5.2 liters versus 3.2 liters in a control digester. Butyrate accumulated to only 10% of the cumulative added butyrate. A second thermophilic digester was infused with propionate at the rate of 10 μmol/ml sludge per day. Propionate accumulated in this digester parallel to the total propionate added for 40 days (two hydraulic detection times). Propionate concentrations then decreased until they reached about 30% of the total added propionate at day 100. Biogas production and methane production was only slightly higher than control digesters. 8 references, 7 figures, 2 tables.

31634 (ANL/CNSV-TM—167, pp 247-260) **Combined metabolism of butyric acid and waste activated sludge at thermophilic temperatures.** McKinney, R.E.; Shamskorzani, R. (Univ. of Kansas, Lawrence). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

A laboratory study was carried out using a 1.5 liter, fixed media anaerobic reactor with intermittent mixing and once daily feeding of Lawrence, Kansas, WWTP waste activated sludge and butyric acid. The research was divided into three phases. Phase 1 was a study of decreasing the hydraulic retention time 10 days to 2 days while keeping the temperature constant at 50°C and the butyric acid COD constant at 3 g/d. Once good operations were established at 2 days retention, the butyric acid COD was increased to 18 g/d at a constant waste activated sludge loading. The digester became saturated with solids at 6 g/d COD and remained saturated for the remainder of the study. The system became overloaded when the total BCOD fed rose from 13.7 g/d to 16.7 g/d. The third phase consisted of feeding waste activated sludge only and increasing the temperature from 50°C to 70°C. Good operations occurred at 50°C, 55°C and 60°C. The methane bacteria began to be adversely affected as the temperature increased. These results indicated that the biodegradable fraction of waste activated sludge was 92% metabolized with 3 days hydraulic retention and 11 days solids retention time at 50°C. The fixed media system gave good anaerobic digestion of both the waste activated sludge and the soluble butyric acid even when the system was saturated with solids. 10 references, 5 figures.

31635 (ANL/CNSV-TM—167, pp 261-282) **Anaerobic digestion of hemicellulosic feedstocks.** Rivard, C.; Himmel, M.; Grohmann, K. (Solar Energy Research Institute, Golden, CO). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Lignocellulosic biomass in its native form is highly resistant to microbial attack. Exceedingly long reaction times (10-90 days) are required for complete microbial conversion of even the more degradable feedstocks such as straw, corn stover and MSW to methane. Controlled acid pretreatment of these feedstocks, besides enhancing the digestibility of the cellulosic residue, liberates soluble hemicellulosic polymers which are further degraded to free sugars by enzymatic hydrolysis within the anaerobic digestion system and ultimately converted to biogas. Pretreatment hydrolysate liquor expressed from straw (a model low value biomass feedstock) cooked at 120°C with dilute phosphoric acid was successfully used as feed in a mesophilic anaerobic digestion system. Stirred and packed bed anaerobic reactors were examined as systems for the conversion of biomass hydrolysate liquor to methane. Various column packing materials for packed bed reactors were also evaluated. After maturation of microbial attachment to the bed material, preliminary rates of 3.5 volumes of biogas (65% methane) per reactor volume per day were attained in the packed bed reactors. The effect on digestor performance of trace quantities of several compounds present in acid hydrolysates of biomass, such as furfural, 5-hydroxy-methyl furfural, low molecular weight lignin and lignin precursors, was also investigated. 19 references, 6 figures, 3 tables.

31636 (ANL/CNSV-TM—167, pp 283-302) **High solids digestion of MSW to methane by anaerobic digestion.** Clausen, E.C.; Gaddy, J.L. (Univ. of Arkansas, Fayetteville). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The anaerobic digestion of lignocellulosic wastes, such as MSW, is quite slow, with retention times of 20-60 days quite common. Because of these slow rates of digestion, reaction vessels for producing methane by anaerobic digestion are quite large. Preliminary process economics have shown capital costs to be quite high, with about two thirds of the costs required for large digesters. Research clearly needs to concentrate on reaction kinetics and decreasing reactor volume in commercial anaerobic digestion processes. This paper examines the feeding of high solids concentrations as a means of directly reducing the required reactor volume. Feed solids concentrations of nearly 30% are possible by feeding liquids and solids separately. The reaction kinetics must not be adversely affected and fluidity of the reactor contents must be maintained. The results of a project to determine the reaction kinetics and maximum MSW concentrations possible are presented. Economic projections for a large-scale facility are developed. 3 references, 3 figures, 7 tables.

31637 (ANL/CNSV-TM—167, pp 303-320) **Gasification of concentrated particulate and solid substrates by biphasic anaerobic digestion.** Ghosh, S. (Institute of Gas Technology, Chicago, IL). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

This paper presents the development and performances of two innovative configurations of the two-phase anaerobic digestion process for gasification of concentrated organic slurries and high-solids feeds. Data are presented to show that the conventional single-stage digestion process is unsuitable for application to high-solids-content and concentrated feeds, and that efficient and rapid-rate gasification of these feeds can be better achieved by separated acidogenic and methanogenic fermentations. A process configuration utilizing upflow acid- and methane-phase digesters was demonstrated to be considerably superior to the conventional single-stage digestion process in terms of methane yield and production rate and

net energy production. This process afforded a methane yield of 0.48 SCM/kg VS added (7.7 SCF/lb VS added) for a sewage sludge feed at a hydraulic residence time of 5.9 days; this performance was better than those reported in the literature for this type of feed. For low-moisture feeds such as MSW, a downflow leach-bed acid-phase fermenter was utilized to liquefy an organic bed of solids to generate a high volatile acids-content bioleachate product, which was sequentially gasified in a separate upflow methane digester. This system, operated under ambient conditions, provided for recycling of the indigenous nutrients, and did not require the addition of any external water; it afforded a methane yield which was 80% of the theoretical value. 5 references, 4 figures, 3 tables.

31638 (ANL/CNSV-TM—167, pp 321-329) **Engineering studies on MSW as substrate for methanogenesis.** Diaz, L.F.; Savage, G.M.; Golueke, C.G. (Cal Recovery Systems, Inc., Richmond, CA). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

This paper is a summary of three studies conducted and reported by the authors on the anaerobic digestion of raw MSW. The first study (1968-1972) was on the digestibility of individual organic components of MSW and of organic refuse as a whole. In the second study (1973-1976) was explored the feasibility of lowering the cost of digestion and simultaneously increasing its efficiency by having it constitute a unit process in a waste treatment-resource recovery facility. Loading rates, and potential advantages from co-digesting sewage sludge and MSW were investigated. The third study (1981-1982) was a determination of the digestibility of outputs of unit processes designed to separate MSW into feedstocks for the recovery of inorganic resources and of organic resources destined for energy recovery. It was a part of a study on the integration of biogasification into an operation designed to thermally recover energy bound in the combustible fraction of the processed wastes. A 70% energy recovery is possible with such an integration. 9 references, 2 figures.

31639 (ANL/CNSV-TM—167, pp 331-341) **Evolution of the RefCOM system.** Pfeffer, J.T. (Univ. of Illinois, Urbana). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

RefCOM is the acronym for the project initiated by the US Department of Energy for demonstration of the biological conversion of refuse to carbon dioxide and methane. In the 1960's and 1970's, a substantial research effort was undertaken to investigate the feasibility of biological conversion of urban refuse to a fuel gas. This research provided basic process parameters needed to develop a conceptual design of such a system. Mass balance and economic evaluations showed that the system had potential. In 1975, a request for proposal was issued by the NSF/RANN program for the design and construction of a proof-of-concept system. Plant startup was initiated in 1978. However, a substantial number of startup problems were encountered. Operation with a modified front-end system was eventually achieved. The biological process was found to function as predicted from the laboratory results. However, numerous operating problems were encountered with the mechanical refuse processing, the feed slurry preparation, the reactor mixing and the slurry dewatering systems. Redesign of these systems was necessary to obtain reliable operation. 14 references, 1 figure.

31640 (ANL/CNSV-TM—167, pp 343-354) **Preliminary evaluation of the effects of A d-RDF binding agent, RDF particle size and heat pretreatment on efficiency of anaerobic digestion of RDF.** Wright, V.K.; Venables, B.J.; Daugherty, K.E. (Cyclic Energies, Inc., Denton, TX). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

A version of an upflow anaerobic sludge blanket (UASB) digester for conversion of biodegradable organics to a high Btu biogas is being evaluated at the pilot plant scale at the City of Denton municipal sewage treatment plant. The digester design under study was originally developed, tested and commercially used for stabilization of food-processing wastes. Hydraulic retention time of 24 hours resulted in a 55% reduction in COD and a 95% reduction in suspended solids. In concert with the development of binder systems for densified-refuse derived fuel (d-RDF), under a Department of Energy/Argonne National Laboratory grant, binding agents and other factors affecting efficiency of anaerobic digestion of potential d-RDF products are being evaluated. Laboratory scale anaerobic digesters demonstrated no effects of two commercially available particle sizes of RDF or the presence of calcium oxide, a potential d-RDF binder, on digestion efficiency. Efficiency was significantly increased by a heated pretreatment. 19 references, 3 tables.

31641 (ANL/CNSV-TM—167, pp 355-374) **New concept for the production of high-But gas from anaerobic digestion.** Hayes, T.D.; Isaacson, H.R. (Gas Research Institute, Chicago, IL). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

A major economic consideration in the use of anaerobic digestion to convert municipal wastes to pipeline quality methane and commercial grade CO_2 is the cost of separating CO_2 from the product gas. Physical/chemical processing for upgrading digester gas (55-65% CH_4) to a methane gas stream meeting Gas Industry specifications ($\leqq$ 95% CH_4) is costly with estimates typically ranging from $1.50-3.00/mmBtu. Certain anaerobic digestion process designs have the potential of achieving higher methane concentrations in the product gas thereby reducing gas cleanup costs. There are at least three inherent features that make anaerobic digestion uniquely suited to gas separations: (1) the presence of a gas/liquid interface, (2) the phased production and utilization of volatile acids, and (3) the capability of anaerobic bacteria to produce methane against elevated gas pressures. Because the solubility of CO_2 in water is many times greater than that of methane, it should be possible to develop reactor schemes capable of achieving efficient separations of these two gases. An equilibrium model has been developed that predicts the methane and CO_2 content of the product gas of a steady state digester as a function of commonly-measured influent and effluent parameters. This model, when tested with existing reactor data, showed good correlation between predicted and observed values for methane content. On the basis of the model and the literature, a two-stage, pH-swing/pressure-swing digestion scheme has been conceptualized that has the potential of directly producing pipeline-quality methane and high-grade CO_2 from municipal wastes and biomass. 24 references, 7 figures, 2 tables.

31642 (ANL/CNSV-TM—167, pp 419-435) **Use of in vitro anaerobic landfill samples for estimating landfill gas generation rates.** Jenkins, R.L.; Pettus, J.A. (Getty Synthetic Fuels, Inc., Long Beach, CA). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The estimation of landfill gas generation rates is required for environmental management and energy recovery. This paper describes a technique for predicting gas generation rates using refuse samples which have been taken at depth under anaerobic conditions in the landfill and transferred to the laboratory for incubation. Sampling operations are conducted in a pilot bore adjacent to the main well bore. The refuse is retrieved from auger loads which have been filled at 10-100 ft below the landfill surface. In the laboratory, anaerobic cylinders are incubated at 100 +- 1 F (mesophilic). Following gas composition changes, a steady state gas composition is achieved which is typical of landfill gas (50-55% CH_4, 40-45% CO_2, $<$ 0.1% O_2, $<$ 0.1% H_2, and 0.5-2% N_2). Biochemically, these observations indicate a shock or upset of methanogenesis as a result of the sampling process. For those samples reaching the steady state, average production rates of 0.1-0.7 ft^3/lb dry refuse/yr have been observed. To date, moisture content of the refuse ap-

pears to be the predominant limiting factor in gas production. 3 references, 10 figures, 4 tables.

31643 (ANL/CNSV-TM—167, pp 437-450) **Methane-oxidizing bacteria in sanitary landfills.** Mancinelli, R.L.; McKay, C.P. (Washburn Univ., Topeka, KA). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The relationship between methane-oxidizing bacteria inhabiting the topsoil of sanitary landfills and the methane content of the soil gas phase has been studied and shown to be significantly correlated ($p \leqq 0.01$). This relationship can be described by the equation $y = y_0e/sup\ z/$, where $z = -b/x$, $y = \%CH_4$ in the soil gas phase and x = number of methane-oxidizers per g of soil. The constants were determined to be $y_0 = 82.6\%\ CH_4$ and $b = 8.9 \times 10^6$ methane-oxidizers per g soil. When the methane content of the soil gas phase, within a sanitary landfill, was greater than 50% the population of methane-oxidizing bacteria did not significantly increase. Preliminary data suggests that approximately 10% of the methane produced in a landfill is consumed and/or transformed by the methane-oxidizing bacteria inhabiting the landfill topsoil. Laboratory and field experiments clearly indicate that the population of methane-oxidizers inhabiting sanitary landfill soil is not limited by its carbon supply (CH_4), but is limited by some other factor(s). 39 references, 3 figures, 1 table.

31644 (ANL/CNSV-TM—167, pp 451-464) **Design, operation, and results of the controlled landfill project Mountain View, California.** Van Heuit, R.E. (EMCON Associates, San Jose, CA). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The Mountain View demonstration project consists of six cells designed to study the effects of water content on gas enhancement, and to verify the synergism between water, buffer, and seed/nutrient content. All cells were constructed in an identical manner and filled with municipal refuse from the City of San Francisco, California. Cells A, B and C received sludge and buffer additions during construction, Cell D received buffer only, Cell E received sludge only, and Cell F (the control cell) received no additions. Despite the fact that no attempt was made to modify the landfilling methods normally employed at the Mountain View Landfill, analysis of cell characteristics after completion of construction indicates that additions were made in a fairly uniform manner. This paper describes the construction and operation of the six demonstration cells, presents the monitoring data to date, provides an analysis of monitoring results and a discussion of problems encountered during the program. 3 figures, 3 tables.

31645 (ANL/CNSV-TM—167, pp 465-474) **Chemical and microbiological analysis of Aveley Landfill, England.** Rees, J.F. (BioTechnica Ltd., Cardiff, Wales). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

This paper describes investigations at Aveley Landfill, England which sought to relate very high rates of gas production with the chemical and microbiological conditions encountered at the site. Ideas will be presented which seek to account for the natural establishment of enhanced gas production at this site. Investigative methods will also be discussed. This site investigation forms part of an extensive program of landfill characterization which sought to define the microbiological and chemical conditions present in a range of different landfill types. Ideas for controlling landfill reactions are presented, these include the controlled addition of appropriate microbes at various stages in the landfill's lifetime. 8 references, 4 figures, 2 tables.

31646 (CONF-850241—, pp 125-131) **Integrating a microcomputer for online monitoring of an existing biomass conversion indirect liquefaction process.** Prasad, B.; Kuester, J.L.; Bellamy, L. (Arizona State Univ., Tempe). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

An IBM 9000 microcomputer is utilized for data acquisition in an indirect liquefaction processing system to produce diesel type fuels from various biomass species. The multi-tasking and multiple port capabilities of the microcomputer are used for interfacing effectively with front end type data acquisition devices to acquire process pressures, temperatures, flows and compositions. Precise process data and data base management along with online mass and energy balances are the principle benefits.

31647 (DOE/CS/20419—T1) **PUROX System gas conditioning pilot plant. Final report, September 1976-September 1977.** (Union Carbide Corp., Tonawanda, NY (USA). Linde Div.). Dec 1979. Contract AC01-76CS20419. 191p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86010373.

The developmental pilot plant was designed to refine and condition the PUROX System offgas to produce a gas suitable for use as a chemical feedstock for an ammonia synthesis plant. Three basic gas processing stages were investigated: hydrogenation, shift conversion, and CO_2 removal. Purpose of the hydrogenation step was to saturate unsaturated hydrocarbons with hydrogen to turn them into paraffinic compounds. The shift conversion step was to convert carbon monoxide into hydrogen and carbon dioxide. Because of the large quantity of carbon monoxide in the gas, the shift conversion step was split into two stages with cooling between stages. A hot potassium carbonate solution was selected as the initial absorbent for CO_2 removal. The pilot plant operation showed that the basic principles for treating the PUROX System offgas to produce a feedstock for a synthesis gas or chemical production facility are technically feasible and sound. Investigations by the catalyst supplier following the pilot operations indicate that the catalyst performed even under adverse conditions. However, the test was not long enough. Problems encountered during the pilot plant operation were: entrainment of liquid droplets in the PUROX System offgas which caused polymerization and coking of the offgas on the direct contact electric heating elements, condensation of heavy impurities in the feed gas which resulted in gums and tar formation in the lines and first stage reactor, carbon deposition on the first stage reactor catalyst, and valve plugging of the PUROX System offgas reciprocating compressor.

31648 (DOE/PC/60805—T10) **Cation promotion effects in zeolite-supported F-T catalysis. Tenth quarterly report, December 1984-February 1985.** Goodwin, J.G. Jr.; Oukaci, R. (Pittsburgh Univ., PA (USA). Dept. of Chemical and Petroleum Engineering). Mar 1986. Contract FG22-83PC60805. 16p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010409.

The current research involves a study of the promotion effects of the neutralizing alkali cations on CO hydrogenation (under typical F-T conditions) over zeolite-supported Ru catalysts. During this quarter, a series of alkali zeolites were prepared by partial exchange of NH_4Y and various alkali cations (Li^+, Na^+, Rb^+). These catalysts were characterized by atomic absorption and flame-emission spectroscopy. The concentration of NH_4+ cations was determined by Kjeldahl analysis. The transformations of olefins (propylene and butene) over these catalysts were investigated under similar conditions as those used for CO hydrogenation over Y-zeolite supported Ru catalysts. 4 refs., 3 figs., 3 tabs.

31649 (DOE/PC/70028—T6) **Improved catalysts for liquid hydrocarbon fuels from syngas. Fifth quarterly technical progress report, October-December 1985.** (Union Carbide Corp., Tarrytown, NY (USA). Tarrytown Technical Center). 1985. Contract AC22-84PC70028. 284p. NTIS, PC A13/MF A01; 1; GPO Dep. File Number DE86010639.

The work reported during this Quarter was directed to exploring and refining the promising developments obtained in the

Fourth Quarter, and focused primarily on the newly developed promotor, X_{11}, which was used in Catalyst 32. In two of the ten runs, the performance of the new Molecular Sieves TC-114 and TC-115 was investigated. Neither produced any improvement over the performance of TC-103. Other runs tested the effects of raising the concentrations of cobalt and X_{11} and varying the pretreatment of the catalyst. At higher cobalt levels the methane production was reduced but stability was impaired. Higher levels of X_{11} produced no apparent improvements at 240C, and had a deleterious effect at 260C. With different methods of pretreating the catalyst there were some improvements in performance, substantial enough to warrant further investigation. A new promoter, X_{13}, tested in combination with X_{11}, improved the catalyst's activity, had no effect on selectivity, and showed excellent stability at 240C but poor stability at 260C. Finally, an exact duplicate of the promising Catalyst 32 (Run 12200-19, Fourth Quarterly Report) was run in an attempt to replicate the earlier results. Aside from a slightly inferior performance at 260C, the replication was successful.

31650 **(EUR—10302-EN) Fischer-Tropsch synthesis of hydrocarbons in the gasoil range. Final report.** Jacobs, P.A.; Leplat, L.; Uytterhoeven, J.B. (Commission of the European Communities, Luxembourg. Directorate-General for Information, Market and Innovation). 1985. 53p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

This work involves the development and optimisation of catalysts for the high selectivity preparation of hydrocarbons, olefins and alcohols from coal. With these catalysts it should be possible to synthesize motor fuels in a direct process which will not require major refinery operations after synthesis. The industrial Fischer-Tropsch catalysts testes (11%-16% Co/kieselguhr) all showed Schulz-Flory behaviour. The results obtained here show that with particular types of catalyst (2% Co/alumina or 8% Ru/alumina) it is possible to achieve selective cuts, differing from the usual type of product distribution obtained with Schulz-Flory kinetics. With both Co and Ru the maximum yield was obtained for dodecane (carbon number 12) and roughly 50% of the yield had a carbon number between 10 and 15. It seems that the pore diameter of the support (varied over a wide range: 25-3000 A) does not influence the product distribution, while the degree of loading with the active metal does: higher carbon numbers are formed with decreasing Co loading, while for Ru the opposite is observed. (orig./EF).

31651 **(NE/TORV—80/1) Final Report, Stage 3.** (Vyrmetoder AB, Taeby (Sweden)). Jan 1980. 46p. (In Swedish). NTIS.

Pilot tests have succeeded in extracting methane from peat bogs by withdrawing, degassing, and reinjecting the groundwater from the bog. Experiments conducted for a year (November 1978-November 1979) at two sites demonstrate that the bacterial production of methane is indeed continuous. One site was a lake-fill moor dominated by reed-sedge vegetation, with a thickness of 20 in.; the other was a raised-bog with high-moor peat moss dominated by white mosses, with a thickness of 10 ft. No observable change in the vegetation occurred during the course of the experiments. Gas produced from such swamps or bogs, after cleanup, could be used for power generation, space heating, or water heating.

31652 **(OTA-E—124) Energy from biological processes. Vol. I.** (Office of Technology Assessment (U.S. Congress), Washington, DC). Jul 1980. 195p. GPO.

Depending on a variety of factors - including the availability of cropland, improved crop yields, the development of efficient conversion processes, proper resource management, and the level of policy support - bioenergy could supply as little as 4-6 quadrillion Btu/yr or as much as 12-17 quads/yr by 2000 (or up to 15-20% of the current US energy consumption). The high prediction comprises up to 10 quads/yr from wood, 0-5 quads from grasses and legume herbage (depending on cropland needs for food production), 1 quad from crop residues, 0.3 quad of biogas from animal manure, and about 0.2 quad of ethanol from grains. The bioenergy conversion processes that would be most efficient in displacing large quantities of oil are direct combustion and gasification for process heat and steam and home heat. Combustion technology for wood is commercially available, while suitable gasification units probably can be developed soon. Assuming that market and feedstock supply conditions are favorable, development and deployment of these technologies could provide the difference of up to 10 quads/yr between the high and low estimates for bioenergy use in 2000, displacing the energy equivalent of 4.5 million bbl/day of premium fuels (oil and natural gas). Both the quantity of biomass that can be obtained on a renewable basis, and the economic, environmental, and other consequences of obtaining it will depend critically on the behavior of growers and harvesters.

31653 **(PB—86-156130/XAB) Methane from biomass and waste. Annual report for 1984. Technical progress report.** Smith, W.H. (Florida Univ., Gainesville (USA). Inst. of Food and Agricultural Sciences). Jan 1985. 230p. NTIS, PC A11/MF A01.

The report summarizes the research conducted in several projects by a wide array of faculty at the University of Florida, researching the production of methane from biomass and waste. Growth and yield data on a wide variety of plant species and varieties in eight plant resource groups are reported on promising species selected from extensive screening trials of over 150 species. Focused intensive research results are summarized for water hyacinth and Napier grass--model species showing yields in excess of 20 dry tons/acre/year. Over 1000 samples were bioassayed for methane yields and the variables affecting conversion to methane were defined. Methanogenesis results covering the spectrum from factors of cellular biology to operating parameters for large digesters. Results emphasize the multiphase Anaerobic Digestion System (MADS) an innovative design that employs leached/packed beds. A comprehensive information management system and an integrated methane form biomass system model (BIOMET) used for research evaluation and program management are described.

31654 **Development of the IGT-RENUGAS process.** Onischak, M.; Babu, S.P.; Bair, W.G. (Institute of Gas Technology, Chicago, IL). *Energy Technology (Washington, D.C.);* **12**: 1803-1814(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The authors review the development of the RENUGAS process, which uses a fluidized-bed instead of a moving-bed gasifier. They describe the process research unit and the gasification test results on feed properties and effects of temperatures. Tests to date show that pressurized gasification at 300 psig, 1390 deg. to 1800 deg. F, and feed rate up to 1050 lb/hr of woody biomass is simple to operate. Total carbon conversion exceeds 92% above 1500 deg. F, and recycling the entrained char could raise that level. Other results identify the oxygen requirement, level of methane production, and the dry gas yield and gross calorific value of the fuel gas, which ranges from 290 to 360 Btu. The process data will be used to conduct environmental assessments and techno-economic analyses. 5 references, 6 figures, 2 tables.

31655 **Impurity modification of surface catalyzed reactions: Methanation over phosphided nickel.** Goodman, D.W.; Kiskinaya, M. New York, NY; American Institute of Chemical Engineers (1985). 13p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC04-76DP00789.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Single crystal catalysts have been used to investigate the methanation reaction over phosphided nickel surfaces. The apparatus used in these studies allows for catalyst preparation and surface characterization in ultrahigh vacuum (UHV) with an in vacuo transfer to a second UHV chamber designed for kinetics at elevated pressures. Kinetic studies on single crystals of nickel have shown the effect of sulfur to be strongly nonlinear where one sulfur atom effectively deactivates ten or more nickel surface atoms. These studies have addressed the role of ensemble effects as opposed to electronic effects in the deactivation mechanism. Studies similar to the previous ones for sulfur have been carried out for phosphorus. These data show phosphorus to be much less effective in attenuating the nickel catalytic activity for methanation. The reduced severity of the poisoning by phosphorus is attributed to its lower

electronegativity. These results are consistent with an electronic effect playing a significant role in the poisoning of nickel methanation activity by sulfur.

0902 Alcohol Fuels

REFER ALSO TO CITATION(S) 32124

31656 (ANL/CNSV-TM—167, pp 375-386) **Ethanol and chemicals from cellulosics in solid wastes.** Tsao, G.T. (Purdue Univ., West Lafayette, IN). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Cellulosic materials contain an average 75% by weight carbohydrates with cellulose and hemicellulose being the major components. Cellulose can be hydrolyzed with either an enzymatic or an acidic catalyst to yield glucose. Hemicellulose is relatively easy to hydrolyze yielding xylose, galactose, mannose, arabinose, and so on. Fermentation can convert hexoses and xylose into ethanol. Meanwhile, many other fermentation processes can also be utilized to produce other useful chemicals. Cellulosic materials can also be converted into valuable products by reactions of organic chemistry. Heterogeneous catalytic reactions can also yield additional useful chemicals. This paper will present discussion on various possibilities of production of fuels and chemicals from cellulosic materials. 5 references, 2 figures, 1 table.

31657 (ANL/CNSV-TM—167, pp 387-405) **Production of chemicals and fuels by acid hydrolysis and fermentation of MSW.** Clausen, E.C.; Gaddy, J.L. (Univ. of Arkansas, Fayetteville). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Concentrated mineral acids may be used to hydrolyze lignocellulosics, such as MSW, to sugars. These sugars may then be fermented to ethanol, organic acids, or other industrial chemicals and fuels. This paper presents data and results for a two-step acid hydrolysis of MSW, followed by the fermentation of the resulting sugars to ethanol. Yields, kinetics and by-products are presented and discussed. Preliminary design and economic projections for a commercial facility to produce 20 mm gallons of ethanol per year using the combined hydrolysis-fermentation process are developed. 7 references, 5 figures, 5 tables.

31658 (ANL/CNSV-TM—167, pp 407-417) **Bioconversion of municipal solid waste and sewage sludge to ethanol.** Coleman, D.R.; Laughlin, T.J.; Kilgore, M.V. Jr.; Lishawa, C.L.; Meyers, W.E.; Eley, M.H. (Southern Research Institute, Birmingham, AL). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

The authors have investigated a system for the bioconversion of municipal solid waste (MSW) and sewage sludge to ethanol. The system has three primary components: MSW processing/fractionation, cellulose hydrolysis to fermentable products, and fermentation/distillation. The novel pretreatment process developed in this study effectively separated the organic and inorganic fractions of unsorted MSW. The cellulose in the organic fraction was readily hydrolyzed to glucose by enzymatic and acid hydrolysis processes. This material was demonstrated to be fermentable. The overall yield was about 40 gallons of ethanol per ton MSW (as received). These economic analyses indicate that a plant processing 1500 tons of MSW per day would require a $90,000,000 capital outlay and that the break even price of ethanol would be $1.50 per gallon (based on ethanol production alone). 8 references, 4 figures, 3 tables.

31659 (ORNL/M—148) **Eighth symposium on biotechnology for fuels and chemicals. Program and abstracts.** (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 110p. (CONF-860508—Absts.). NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86010058.

From 8. symposium on biotechnology for fuels and chemicals; Gatlinburg, TN, USA (13 May 1986).

The proceedings of the Eighth Symposium on Biotechnology for Fuels and Chemicals are contained in this publication. Sessions were held on thermal/chemical processing, applied biological research, bioengineering research, chemicals from tissue culture, and value-added chemicals. (DT)

31660 **Ethanol production from cellulose by a coculture of Zymomonas mobilis and a clostridium.** Leschine, S.B.; Canale-Parola, E. (Univ. of Massachusetts, Amherst). *Current Microbiology;* **11**: 129-136(1984). Contract AC02-81ER10878.

Zymomonas mobilis and a mesophilic cellulolytic clostridium (strain C7) were grown in coculture in a medium containing cellulose as fermentable substrate. The coculture was stable through at least ten serial transfers and produced markedly higher amounts of ethanol than monocultures of the cellulolytic clostridium. Glucose and cellobiose, derived from the breakdown of cellulose, accumulated in strain C7 monocultures, but not in cocultures. The molar ratio of ethanol to acetate was higher in cocultures than in monocultures of strain C7. The cellulolytic clostridium was relatively ethanol-tolerant, inasmuch as it grew and fermented cellulose in media containing up to 7 g of ethanol/100 ml. Cellulase (Avicelase) activity of strain C7 was inhibited by cellobiose, but not by glucose. 18 references, 4 figures, 4 tables.

31661 **Phase separation of organics/water mixtures using salts.** Donaldson, T.L. (Oak Ridge National Lab., TN). *Biotechnology and Bioengineering Symposium;* No. 14, 573-579(1984). Contract AC05-84OR21400.

The miscibility of water and organic liquids is affected by the presence of inorganic salts. In general, the miscibility is decreased such that a water/organics mixture can be induced to separate into two liquid phases by the addition of a salt. In the case of a dilute solution of fermentation product in water, it is sometimes possible to obtain a relatively small volume of an organic-rich phase and a relatively large volume of an aqueous phase containing negligible organics. This separation can be achieved at ambient conditions. Liquid-liquid phase separation may offer unique benefits for certain separation and purification problems. Although relatively high separation factors can be realized, further purification of the product-rich phase by distillation, extraction, or other means would probably be desirable in practical applications. In this paper the phase-separation phenomenon is illustrated using several examples, the thermodynamic basis for phase separation is reviewed, the characteristics of an efficient salt are identified, and a conceptual process flowsheet is discussed. 10 references, 5 figures, 1 table.

0904 Solid Waste And Wood Fuels

REFER ALSO TO CITATION(S) 31698

31662 (DOE/CS/40420—T1) **In-forest dried (IFD) wood residue fuel technology development. Final report on batch IFD system.** (Gorham International, Inc., ME (USA)). Mar 1986. Contract FC07-81CS40420. 86p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010582.

A system has been developed to acquire and process forest residues from logging operations for use as an industrial fuel. The Gorham In-Forest Dried (IFD) Wood Residue Fuel System combines several functional elements which are carried out by one of three participants: a logger who harvests the residues of his operation, along with traditional roundwood and sawlog products (coharvesting); a fuel wood vendor who chips and dries the residues and transports the dry residue chips; and an industrial customer who uses the residue chips (primarily owners of package oil and natural gas fired boilers). The motivation for the system, affecting its overall and specific configuration, is lower capital and operating

costs at the user site. The IFD Residue Fuel Technology Development Project has progressed through two phases of work. Overall project objectives included: defining, developing and implementing methods and procedures for small-scale integrated harvesting of roundwood and residues; more fully defining the activities and operations of the fuel wood vendor; adaptation and application of prototype gasifiers to in-forest drying; design and procurement of heat and power and drying equipment; testing and modification of equipment; and examination of issues relevant to industrial use of IFD residue chips.

0906 Gaseous Waste Fuels

31663 (INIS-mf—9886, pp 20-23) **Gas from waste dumps - a source of danger or of energy.** Merkel, E. Jan 1985. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752052.

In State Authority for Water and Waste Management of North-Rhine Westphalia. Annual report '84.

In dumps of household wastes gas is generated that is dangerous for man, animals and plants. In newer deposits one therefore installed plants which recover the gas and pump it off. This gas ought to be used for heat- or power generation. Old dumps are a problem as there is insufficient knowledge about the nature and variety of the deposited material. The danger potential is therefore difficult to estimate. So far a first step registration all old dumps by districts and city authorities. In urgent cases the State Authority inspects old dumps by means of a mobile gas measuring station, it tries to determine the potential danger and makes suggestions how to fend it off. Old dumps situated close to residential quarters must be inspected first. (orig.).

13 HYDRO ENERGY

1306 Environmental Aspects

REFER ALSO TO CITATION(S) 31980

31664 **Diverting structure's effects on a river flow time series.** Downing, D.J.; Pack, D.J.; Westley, G.W. (Oak Ridge National Lab., TN). *Management Science;* **29**: No. 2, 225-236(Feb 1983). Contract W-7405-ENG-26.

A step-by-step summary of an empirical time-series analysis of the effects of a newly constructed dam on river flow rate is given. A model of river flow rate for the 522 weeks of data is built through the transfer function/intervention model development processes of Box-Jenkins/Box-Tiao. Analysis indicates a rainfall variable has a significant influence on the pre-dam flow rate but not on the post-dam flow rate. The model also reflects a differing relationship of rainfall to pre-dam flow rate depending on the season of the year. Physical interpretations of model parameters and determination of implied mean flow rates suggest that the final model provides a sound basis for some public policy decisions that might focus on the dam. 6 references, 3 figures, 8 tables.

1307 Power-conversion Systems

REFER ALSO TO CITATION(S) 32462

14 SOLAR ENERGY

REFER ALSO TO CITATION(S) 31990, 31991

31665 **(AD-A—163983/0/XAB) Radiation augmented propulsion feasibility. Final report, 17 September 1984-28 September 1985.** Hurlock, S.C.; Quan, V.; Blauer, J.; Hall, J.R.; Wagner, R.I. (Rockwell International Corp., Canoga Park, CA (USA). Rocketdyne Div.). Dec 1985. 113p. (RI/RD—85-257). NTIS, PC A06/MF A01.

Gas-phase absorption of solar radiation has been suggested as an energy source to power space propulsion systems. The absorbing gas could be an expendable propellant or could be used in a closed cycle, exchanging heat with an expendable propellant. This study was conducted in order to develop basic data and understanding useful for the evaluation of such a system with the absorbing gas being a halogen or an interhalogen. Experiments and analysis were conducted to characterize the absorption of ultraviolet and visible radiation and subsequent energy release in chlorine gas, iodine monochloride vapor, and mixtures of hydrogen gas and chlorine gas. Xenon flashlamps were used to provide the radiation. Measurements included lamp electrical and optical characteristics, light energy absorbed, pressure rise in the closed reactor and reactants remaining after the reaction. Analysis included detailed kinetic modeling of the single-shot experiments.

31666 **Solar thermal research program.** Gupta, B.P.; Carasso, M.; Nix, R.G. (Solar Energy Research Institute (SERI), Golden, CO). *Energy Technology (Washington, D.C.);* **12**: 1612-1621(Aug 1985). (CONF-850301—). Contract AC02-83CH10093.

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The Solar Energy Research Institute (SERI) conducts basic and applied research in materials, thermal sciences, chemical sciences, and engineering analyses for new solar thermal energy system technology. The overview reviews collection technology research on optical materials, concentrators, and receivers and energy conversion research on thermally regenerative electrochemical systems and photo/thermochemical processes. In addition to the long-term performance and cost targets for electricity and heat, the research program explores new an innovative ideas for other applications for which definitive goals and targets can be established only after more information is available. 3 figures.

1401 Resources And Availability

31667 (CONF-850241—, pp 139-142) **Model 100 as a stand alone unit in tracking and data acquisition.** Castle, K.R. (Talandic Research Corp., Tucson, AZ). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

An ongoing experiment, utilizes the Radio Shack TRS-80, Model 100 computer as a data acquisition tool. The experiment requires a specialized instrument to be utilized, which makes irradiance measurements of the sun and radiance measurements of the sky at ten selected wavelengths, using narrow band spectral filters. The instrument contains five stepper motors for rotating two filter wheels, one field stop wheel, one polarizer/waveplate assembly (for making polarization measurements) and one detector assembly. An absolute encoder system is used with each motor. The Model 100 controls all of these functions, in addition to recording the data output from the detectors. High speed, low power CMOS chips are used in the interface between the computer and instrument, and a twelve bit A/D is used to convert the detector voltage into digital numbers. Exclusive use is made of the Model 100 BASIC language, particularly the INP and OUT commands. A forth pin socket on the bottom of the Model 100 provides access to the sixteen address and data lines, as well as to the RD, WR, IO/M and ground lines. The interface circuit is made up of gates, buffers and latches which, when properly strobed, enables the computer to send or receive data, as required. The instrument is mounted on a tracking stand capable of absolute positioning. All tracking is done under the control of the Model 100. The instrument is initially aimed at the sun, to define a reference point. A software program then calculates the solar position as it changes, based on the date and current time supplied by the computer. The time signals from WWV are used to reset the Model 100 before each data run. A time interrupt routine enables the computer to update the solar position every thirty seconds, and to acquire data at specific times.

31668 (SERI/CP—215-2773, pp 1-11) **Solar radiation topical overview.** Hulstrom, R.L. (Solar Energy Research Institute, Golden, CO). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

An overview of solar radiation (insolation) research and assessment as it pertains to the photovoltaic (PV) solar energy conversion technology and industry is presented. The overview consists of four fundamental areas: resource data, measurements and monitoring, models, and instrumentation. Information on each of these areas generally consists of: importance to the photovoltaic solar energy conversion technology and industry, needs, current information, and future work.

31669 (SERI/CP—215-2773, pp 15-29) **Solar radiometry instrumentation, calibration techniques, and standards.** Zerlaut, G.A. (DSET Labs., Inc., Phoenix, AZ). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The types and classes of solar radiometers applicable to photovoltaic conversion are discussed in relation to the geometrical and spectral characteristics of terrestrial sunlight and, hence, the requirements placed on solar instrumentation. Primary and secondary reference standards are discussed from the point-of-view of the World Meteorological Organization and general meteorological convention. A discussion of the characterization of primary reference standards and the calibration of secondary reference standards is presented in relation to absolute cavity pyrheliometers and pyranometers, respectively. The standardization of characterization and calibration methods through the development of domestic and international consensus test standards (procedures) is discussed. The relation between domestic and international standard methods is given. The hierarchy of standards organizations are detailed from the perspective of solar radiometry.

31670 (SERI/CP—215-2773, pp 33-40) **Characteristics of network measurements.** Flowers, E.C.; Maxwell, E.L. (NOAA, Boulder, CO). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The historical NOAA solar network data are described in detail and excellent descriptions of other networks are presented. This report focuses on those aspects of network measurements not covered elsewhere, namely, the effects of generic instrument characteristics on the measurements. The instrument characteristics are of such a magnitude that comparisons of measurements between networks or within networks where a variety of instruments is used can only be properly understood if the various instrument characteristics are recognized and acknowledged.

31671 (SERI/CP—215-2773, pp 43-52) **Solar irradiance conversion models.** Perez, R.; Stewart, R. (State Univ. of New York, Albany). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

There are three basic levels of modeling which might be considered when estimating, on an hourly basis, the irradiance received by a sloping surface in a given location, depending upon the data available to the user. These three types of models are: conversion or transposition models that use available direct and horizontal global or diffuse hourly irradiance records to compute hourly global irradiance values on tilted planes; models which use hourly global radiation as input, to generate the diffuse and direct components needed to obtain values for titled plants; and models which generate both global and/or direct irradiance from other quantities, such as percent sunshine, cloud cover, satellite imagery, etc. The study focuses on the first type of models. It is, therefore, assumed that global and direct hourly data are either available (which is the case for over 40 locations in the US), or accurately modeled. The need for adequate modeling in this area is crucial for both HVAC and PV system designers, as instantaneous computational errors may reach 200 omega/m^2 under certain circumstances. A recent study showed that transposition models could be the largest source of error, depending on the model used, associated with the simulation of PV systems.

31672 (SERI/CP—215-2773, pp 55-64) **Spectral solar irradiance models and data sets.** Riordan, C.J. (Solar Energy Research Institute, Golden, CO). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The spectral distribution of solar irradiance at the earth's surface varies with the elevation of the sun above the horizon and atmospheric conditions. This variation is important to photovoltaic (PV) applications because PV devices are spectrally selective. Therefore, data on the spectral distribution of irradiance throughout the day and year for different climates are required to predict the field performance of PV devices and to design devices for optimum energy conversion efficiency at specific locations. The nature of spectral irradiance variations and their impact on PV device performance, the models and data sets used to characterize spectral irradiance variations, and issues related to the specification of spectral irradiance conditions for PV device performance analyses are reviewed.

31673 (SERI/CP—215-2773, pp 67-75) **Spectral solar irradiance instrumentation and measurement techniques.** Cannon, T.W. (Solar Energy Research Institute, Golden, CO). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

A direct-beam outdoor solar spectrum is discussed. The spectral responses of four representative photovoltaic materials superimposed on the spectral plot differ significantly from each other and overlap various portions of the spectrum. The responses of the narrow-band-gap materials, which require less energy to create charge pairs, extend further into the long-wavelength (lower energy photon) portion than the wide-gap materials. The short-circuit current density may be predicted by multiplying the spectral response (short-circuit current density per unit incident power density) by the spectral irradiance (incident power density per unit wavelength) on a wavelength-by-wavelength basis, and then adding the products. Current density is, therefore, related to the distribution of spectral irradiance within the overlapping region of the two curves. Calibration number CN (short-circuit current divided by total incident power for all solar-spectral wavelengths) on the other hand, is sensitive to the out-of-band spectral irradiance and hence to the partitioning of the solar irradiance, as well.

1403 Economics

REFER ALSO TO CITATION(S) 31694

1405 Solar Energy Conversion

REFER ALSO TO CITATION(S) 31621, 31622, 31623, 31624, 31625, 31626, 31627, 31628, 31629, 31630, 31631, 31632, 31633, 31634, 31635, 31636, 31637, 31638, 31639, 31640, 31641, 31642, 31643, 31644, 31645, 31646, 31652, 31653, 31656, 31657, 31658, 31672, 31673, 32354, 32384, 32782, 32808, 32809, 32810, 32836

31674 **(BMFT-FB-T—85-158) Longterm energy storage in zeolites for utilizing solar energy process heat. Final report.** Hallermayer, R.; Jung, D.; Khelifa, N.; Laevemann, E.; Sizmann, R. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.); Muenchen Univ. (Germany, F.R.). Sektion Physik). Dec 1985. 110p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752005.

Thermochemical energy storage exhibits several advantages compared with sensible heat storage: energy storage densities equivalent useful heat between 100 and 1000 kWh/m^3 compared to ca 40 kWh/m^3 in sensible heat storage taking account of the volume of thermal insulation, no heat losses during long term storage and variable temperature level between charging and discharging. We report on zeolites and silicagels as adsorbentia and water vapor as adsorbate. The adsorption isosteres, isothermals and enthalpies were experimentally determined. The process operates at ambient pressure, with air as inert carrier gas for water vapor and

heat. Energy densities around 200 kWh/m³ were realised. The charging cycle (desorption of water) requires hot air (driven through the pellet-bed by a blower) of about 200°C for zeolite or 80°C for silicagel. In the discharging cycle (adsorption of water vapor) wet air is blown through the pellet bed of dry adsorbent. The heat of adsorption is removed as warm dry air and can be utilized for domestic or process heat. (orig./HW). With 34 refs., 8 tabs., 55 figs.

31675 **(BMFT-FB-T—85-160) Deposition of crystalline semiconductor layers on amorphous substrates ('Graphoepitaxy'). Final report.** Raeuber, A.; Hirth, H. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 66p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752003.

The aim of the project was the preparation or oriented monocrystalline GaAs layers on insulating substrates. Oxidized silicon wafers served as the preferred substrates because of their excellent surface quality and because of the possible development their excellent surface quality and because of the possible development of Si/SiO_2/GaAs sandwich structures. GaAs was deposited mainly by CVD techniques like the Tietjen process. Nucleation and overgrowth experiments have been performed using etched or deposited structures of a few μm dimensions as nucleation activators. The selectivity of nucleation was very high, surfaces without activation staying completely free of deposition. Nucleated crystals were in many cases uniform in orientation but not uniform in diameter. Overgrowth experiments were successful when growth was startet on a GaAs substrate but were difficult with nucleated crystals. (orig.). With 46 refs., 19 figs.

31676 **(DOE/CE/10093—H1) Annual progress report: photovoltaics, FY 1985.** (Solar Energy Research Inst., Golden, CO (USA)). Apr 1986. Contract AC02-83CH10093. 30p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010486.

Progress is reported in the areas of: photovoltaic materials research; cell and module design for flat and concentrator solar cell arrays; systems research to verify module and subsystem performance and system integration. (LEW)

31677 **(DOE/CE/15239—T2) Photovoltaic Membrane (PVM) Roof System. Technical progress report, first quarter 1986.** Francovitch, T.F. (Single-Ply Inst. of America, Inc., Pasadena, MD). 28 Apr 1986. Contract FG01-85CE15239. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86009742.

Testing of the Photovoltaic Membrane Roof System for wind uplift resistance is reported. A wind uplift table was used to simulate this load by applying positive pressure to a section of roof. Four such tests were conducted, using reinforced EPDM, Gates' reinforced Hypolon, and reinforced PVC. (LEW)

31678 (DOE/JPL—1012-111, pp 3-10) **Crystalline-silicon reliability lessons for thin-film modules.** Ross, R.G. Jr. (Jet Propulsion Lab., Pasadena, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

During the past 10 years the reliability of crystalline-silicon modules has been brought to a high level with lifetimes approaching 20 years. With the emergence of thin-film power modules it is important to review the lessons learned from the crystalline-Si product development history and apply the technology base, where applicable, to enhance the development of thin-film modules. New cell materials and monolithic structures will require new device processing techniques, but the package function and design will evolve to a lesser extent. Although there will be new encapsulants optimized to take advantage of the mechanical flexibility and low-temperature processing features of the thin-films, the reliability and life-degradation stresses and mechanisms will remain mostly unchanged. Key reliability technologies in common between crystalline and thin-film modules include hot-spot heating, galvanic and electrochemical corrosion, hail-impact stresses, glass breakage, mechanical fatigue, photothermal degradation of encapsulants, operating temperature, moisture sorption, circuit design strategies, product safety issues, and the process required to achieve a reliable product from a laboratory prototype. These technologies are discussed.

31679 (DOE/JPL—1012-111, pp 13-31) **Light-induced effects-impacts to module performance measurements and reliability testing: an overview.** Wronski, C.R. (Exxon Research and Engineering Co., Annandale, NJ). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

The stability of solar cells is a key factor in determining the reliability of photovoltaic modules and is of great interest in the case of solar cells having a new technology which has not yet been fully developed. In particular this question arises with hydrogenated amorphous silicon (a-Si) solar cells because a-Si exhibits reversible light-induced changes in its electronic properties, commonly referred to as the Staebler-Wronski effect (SWE). Continuous progress is being made in the peak conversion efficiencies of a-Si solar cells and efficiencies in excess of 11% have been achieved. Progress resulting from the continuous improvements made in material synthesis, device processing as well as the introduction of new device structures is discussed.

31680 (DOE/JPL—1012-111, pp 33-45) **Thin-film module circuit design - practical and reliability aspects.** D'Aiello, R.V.; Twesme, E.N. (Solarex Thin Film Div., Newtown, PA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

Several aspects of the design and construction of submodules based on thin-film amorphous silicon (a-Si) pin solar cells are discussed. Starting from presently attainable single cell characteristics, and a realistic set of specifications, practical module designs are discussed from the viewpoints of efficient designs, the fabrication requirements, and reliability concerns. The examples will center mostly on series interconnected modules of the superstrate type with detailed discussions of each portion of the structure in relation to its influence on module efficiency. Emphasis will be placed on engineering topics such as: area coverage, optimal geometries, and cost and reliability. Practical constraints on achieving optimal designs, along with some examples of potential pitfalls in the manufacture and subsequent performance of a-Si modules will be discussed.

31681 (DOE/JPL—1012-111, pp 47-64) **Hot-spot heating susceptibility due to reverse bias operating conditions.** Gonzalez, C.C. (Jet Propulsion Lab., Pasadena, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

Because of field experience (indicating that cell and module degradation could occur as a result of hot-spot heating), a laboratory test was developed at JPL to determine hot-spot susceptibility of modules. The test parameters were selected in the following way. For high-shunt resistance cells the applied back-bias test current was set equal to the test cell current at maximum power. For low-shunt resistance cells, the test current was set equal to the cell short-circuit current. The shadow level was selected to conform to be that which would lead to maximum back-bias voltage under the appropriate test current level. The test voltage was determined by the bypass diode frequency. The test conditions were meant to simulate the thermal boundary conditions for 100 mW/cm², 40 C ambient environment. The test lasts a total of 100 hours. A key assumption made during the development of the test is that no current imbalance results from the connecting of multiparallel cell strings.

31682 (DOE/JPL—1012-111, pp 65-77) **Accelerated stress testing of thin film solar cells - development of test methods and preliminary results.** Lathrop, J.W. (Clemson Univ., SC). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

The reliability characteristics of solar cells intended for low-cost terrestrial applications, either central power generation or distributed residential usage, will be a key factor in determining the economic feasibility of such systems. Typical cost models are based on a 30-year module life, which is generally accepted to mean that the power output of an array should not decrease by more than 10% during this period. The achievement of such a degree of system reliability requires the use of very stable cells. A program to assess the relative reliability attributes of silicon solar cell technologies through laboratory accelerated stress testing since 1977 is discussed. Much information has been gathered on crystalline cells whose starting material was produced by a variety of techniques - Czochralski, EFG, dendritic, and HEM. Recently attention has turned to thin film technology. The methodology of using accelerated testing to evaluate the reliability attributes of this type of cell is described. The necessary conditions for initiating a comprehensive thin film test program including test samples, accelerating stresses, and electrical measurement techniques are discussed and some preliminary test results related to commercial a-Si cells are given.

31683 (DOE/JPL—1012-111, pp 79-91) **Electrical safety requirements: implications for the module designer.** Sugimura, R.S. (Jet Propulsion Lab., Pasadena, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

Commercial photovoltaic array installations, which include residential and intermediate applications, are subject to building and electrical codes and to product safety standards. The National Electrical Code (NEC) Article 690, titled Solar Photovoltaic Systems, contains provisions defining acceptable levels of system safety and emphasizes the system design and its installation. The Underwriters Laboratories, Inc. (UL), document titled Proposed First Edition of the Standard for Flat-Plate Photovoltaic Modules and Panels, UL-1703, identifies module and panel construction requirements that ensure product safety. Together these documents describe requirements intended to minimize hazards such as shock and fire. A major safety concern is insulation breakdowns within the module or array wiring system, or discontinuities within the electrical conductors. These failures can result in ground faults, in-circuit arcs, or exposure to hazardous electrical parts. Safety issues include: allowable construction practices, electrical insulation system integrity and grounding requirements, and environmental durability. These safety-related features are evaluated at the system level in terms of compliance with electrical codes, and at the component (module) level in terms of satisfying product safety standards. This presentation is intended to provide a basic understanding of the electrical safety implications for the module designer of thin-film modules.

31684 (DOE/JPL—1012-111, pp 95-111) **Large-area thin-film modules.** Tyan, Y.S.; Perez-Albuerne, E.A. (Eastman Kodak Co., Rochester, NY). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

The low-cost potential of thin-film solar cells can only be fully realized if large-area modules can be made economically with good production yields. Two of the critical challenges are discussed. A scheme is presented which allows the simple, economical realization of the long recognized, preferred module structure of monolithic integration. Another scheme reduces the impact of shorting defects and, as a result, increases the production yields. Analytical results demonstrating the utilization and advantages of such schemes are discussed.

31685 (DOE/JPL—1012-111, pp 113-124) **Interconnect resistance of photovoltaic submodules.** Volltrauer, H.; Eser, E.; Delahoy, A.E. (Chronar Corp., Princeton, NJ). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

Small area amorphous silicon solar cells generally have higher efficiencies than large interconnected submodules. Among the reasons for the differences in performance are the lack of large area uniformity, the effect of non-zero tin oxide sheet resistance, and possibly pinholes in the various layers. Another and usually small effect that can contribute to reduced performance of interconnected cells is the resistance of the interconnection, i.e., the series resistance introduced by the metal to tin oxide contact through silicon. There is another effect which can, under certain circumstances, be important. It is due to small parasitic cells resulting from the patterning of the submodule. This effect is described.

31686 (DOE/JPL—1012-111, pp 125-136) **Thin film module development.** Jester, T. (ARCO Solar, Inc., Chatsworth, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

A5w thin film silicon photovoltaic module, the Genesis G100 is described. As the first commercially available thin film product, the G100 module package incorporates excellent reliability, manufacturing ease, and consumer aesthetics. The evolution of the Genesis module is outlined with emphasis on the design and construction of this commercial product.

31687 (DOE/JPL—1012-111, pp 137-149) **Amorphous silicon module development in Sohio.** Hartman, R.A. (Standard Oil Co., Cleveland, OH). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

The development of amorphous silicon solar cell modules by Sohio is presented in outline form. The following topics are presented: amorphous silicon, metallization, module circuit, encapsulation, gasket, frame, specifications, and qualification tests.

31688 (DOE/JPL—1012-111, pp 151-164) **Amorphous silicon photovoltaic modules and test devices design, fabrication and testing.** Leeuwen, M.V. (Hughes Aircraft Co., Long Beach, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

The design, fabrication and testing of 10 thin film amorphous silicon (a-Si) photovoltaic power modules are discussed. These modules were slated to be 1 ft x 4 ft in size. They were to be preceded by the delivery of 10 a-Si 4 in. square test devices. The experience gained and the lessons learned while performing these tasks are presented. Since the primary objective of this effort was to evolve an environmentally survivable thin film module, an integral part of this program is the testing and evaluation of the various materials and manufacturing processes used in module fabrication.

31689 (DOE/JPL—1012-111, pp 167-183) **Thin film module, electrical configuration vs. electrical performance.** Morel, D.L. (ARCO Solar, Inc., Chatsworth, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

In spite of the worldwide interest in thin film Si:H (TFS) as the leading film PV material, relatively few reports on module and device design have appeared. The differences in performance and design options for TFS relative to crystalline Si are significant enough to warrant redevelopment of much of the current design methodology which is largely based on crystalline Si. Several as-

pects of this design issue are reviewed. The intent is merely to highlight the main points of those studies since they relate to the general issues of TFS module design. The effect of module stability on design is discussed. The changes in module output as they are presently known and understood impact future designs as well as some of what has already been done where constant output was assumed.

31690 (DOE/JPL—1012-111, pp 185-195) **Outdoor performance testing of thin-film devices.** DeBlasio, R. (Solar Energy Research Institute, Golden, CO). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

Outdoor (global) testing of PV cells, submodules, modules, and arrays is discussed. Engineering and analysis to identify and determine how technical issues such as cell/module/system adaptations, long-term stability, reliability, economics, materials availability, safety, and environmental impacts affect the development and ultimate use of advanced PV thin film, innovative cell and material technologies are also discussed. A major thrust of the research effort is to develop and utilize instrumentation and procedures for monitoring and analyzing PV cells and submodules including outdoor performance and stability testing and life-cycle accelerated stress testing. Through testing and simulation, researchers can identify problems that require further laboratory research and can help to focus, as well as support, advanced PV systems research. The outdoor testing operations are presently divided into four functional areas: (1) outdoor performance testing; (2) stability performance testing; (3) accelerated stress testing, and (4) systems simulation testing. An overview of outdoor performance and stability testing capabilities at SERI, selected test results, and performance trends are presented.

31691 (DOE/JPL—1012-111, pp 197-234) **Module voltage isolation and corrosion research.** Mon, G.R. (Jet Propulsion Lab., Pasadena, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

A summary of recent research at JPL on two topics related to achieving long-term reliability of photovoltaic modules is presented: voltage isolation and electrochemical corrosion. Special emphasis is given to similarities and differences in performance between crystalline-silicon modules and amorphous-silicon modules.

31692 (DOE/JPL—1012-111, pp 235-248) **Glass breaking strength - the role of surface flaws and treatments.** Moore, D. (Jet Propulsion Lab., Pasadena, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

Although the intrinsic strength of silicon dioxide glass is of the order of 10^6 lb/in.^{2}, the practical strength is roughly two orders of magnitude below this theoretical limit, and depends almost entirely on the surface condition of the glass, that is, the number and size of flaws and the residual surface compression (temper) in the glass. Glass parts always fail in tension when these flaws grow under sustained loading to some critical size. Although the fundamentals of glass breakage are directly applicable to thin-film modules, the fracture strength of typical commercial glass must be replaced with data that reflect the high-temperature tin-oxide processing, laser scribing, and edge processing peculiar to thin-film modules. The fundamentals of glass breakage applicable to thin-film modules are reviewed and preliminary fracture-strength data for a variety of 1-ft-square glass specimens representing pre-processed and post-processed sheets from current amorphous-Si module manufacturers are presented.

31693 (DOE/JPL—1012-111, pp 249-274) **Encapsulant selection and durability testing experience.** Cuddihy, E.F. (Jet Propulsion Lab., Pasadena, CA). 1 Oct 1985. NTIS, PC A13/MF A01. File Number DE86003140. (JPL-PUB—85-73; JPL—5101-264; CONF-8503190—).

From Forum on reliability and engineering of thin-film photovoltaic modules; Washington, DC, USA (20 Mar 1985).

The Flat-Plate Solar Array Project (FSA) has established technically challenging cost and service-life goals for photovoltaic modules. These goals are a cost of \$70/m^2, and an expected 30 years of service life in an outdoor weathering environment. Out of the cost goal, \$14/m^2 is allocated for encapsulation materials, which includes the cost of a structural panel. At FSA's inception in 1975, the cumulative cost of encapsulation materials in popular use, such as room-temperature vulcanized (RTV) silicones, aluminum panels, etc., greatly exceeded \$14/m^2. Many of these new materials are low-cost polymers that satisfy module engineering and encapsulation processing requirements but unfortunately are not intrinsically weather-stable. This necessitates identifying lifetime and/or weathering deficiencies inherent in these low-cost materials and developing specific approaches to enhancing weather stability. In addition, relevant accelerated aging techniques must be developed to enable assessment of encapsulation system lifetimes. Specific items include the development of chemically attachable stabilization additives, computer-assisted kinetic modeling of outdoor weathering reactions, and the use of novel outdoor heating racks and controlled environmental reactors in accelerated aging techniques. Other encapsulation technologies related to life and durability include soiling, electrical insulation, and primers and adhesives.

31694 **(ENEA-RT/FARE-SDI—83-2) SAMICS methodology to analyze cost per unit product in industrial process: photovoltaic application.** Sciortino, M.; Sena, G. (ENEA, Casaccia (Italy). Dipartimento Fonti Alternative Rinnovabili e Risparmio Energetico). 1983. 100p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86901366.

This report describes the SAMICS (Solar Array Manufacturing Industry Costing Standard) methodology that is a standard procedure to evaluate the final cost per unit product according to the different expense items involved in the industrial process. The methodology and the derived simulation code were issued under the Low Cost Solar Array Project (LSA) of the Department of Energy (DOE).

31695 **(EUR—9976-FR) Hydrogenated amorphous silicon photovoltaic cells. Final report.** Chenevas-Paule, A.; Cuchet, R.; Vieux-Rochaz, L. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France)). 1985. 57p. (In French). Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energie.

The purpose of this work is to realize by R.F. sputtering two stacked photovoltaic structures in view of increasing the conversion efficiency of hydrogenated amorphous silicon solar cells. The dual Schottky structure must enhance the short-circuit current Jcc by an electrical parallel connection of two diodes, while the twin (dual) p-i-n structure must double the open circuit voltage Voc by in-series connecting two junctions. We have first elaborated elementary Schottky and p-i-n diodes which have been electrically investigated. P-i-n diodes offer better Voc but weaker Jcc than Schottky diodes. Good tunnel junctions have been realized and have allowed to double the value of Voc in stacked p-i-n structures. On the other hand, the attempt to make dual Schottky structures was not successful, resulting in low Voc values without any increase of Jcc. These results prove that an effective enhancement of the efficiency will be possible only with multispectral stacked junctions. (orig.).

31696 (EUR—9990-EN, pp 79-113) **Pt. II: Biomass from offshore sea areas of Europe.** Morley, J.G. (Liverpool Univ., UK. Dept. of Marine Biology; Nottingham Univ., UK. Wolfson Inst. of Interfacial Technology). 1985. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

In Part I: The cultivation of large brown coal algae as an energy crop. - Part II: Biomass from offshore sea areas of Europe.

A preliminary investigation into the feasibility of utilising marine biomass as a renewable energy source has been carried out. It is envisaged that seaweed would be grown on horizontal polypropylene ropes moored at intervals and buoyed so as to float near

the surface of the water. Seaweed growth rates of about 15 kg (fresh weight) per metre of rope per year have been observed. This is equivalent in energy terms to about 1 kg of coal. Since the seaweed would be grown on artificial substrates, growth would not be limited by sea bed conditions. The potential scale of the resource is thus very large. In the first arrangement considered the seaweed would be harvested by boat and converted to methane by anaerobic digestion. The second arrangement proposes a combined wind turbine/marine biomass farm. In this arrangement the wind turbine towers would be used as anchorage points for the ropes used for the growth of seaweed. The seaweed would be air dried by being winched slowly out of the water at appropriate times of the year using power from the wind turbines. The dry biomass would be collected into hoppers attached to the wind turbine towers. This would then be collected by boat. Model studies of harvesting procedures using submerged barges have also been carried out. A preliminary assessment of the major factors affecting the commercial feasibility of the project has been made and it is suggested that a combined marine biomass wind turbine energy farm offers the best commercial prospects. (orig./EF).

31697 **(EUR—9990-EN) Part I: The cultivation of large brown coal algae as an energy crop. - Part II: biomass from offshore sea areas of Europe.** Jones, J.M.; Holt, T.J.; Morley, J.G. (Commission of the European Communities, Luxembourg. Directorate-General for Information, Market and Innovation). 1985. 119p. European Community Information Service, 2100 M St., NW, Suite 707, Washington, DC 20037.

Energy.

The two parts of the report are abstracted and indexed separately.

31698 **(EUR—10013-EN) Experimental assessment of native and naturalized species of plants as renewable sources of energy in Great Britain. Final report.** Callaghan, T.V.; Scott, R.; Lawson, G.J.; Mainwaring, A.M. (Commission of the European Communities, Luxembourg. Directorate-General for Information, Market and Innovation). 1985. 256p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

Natural vegetation could be used as a renewable source of energy where it is particularly extensive or productive. Experiments have been established to investigate the effects of weather, time of harvesting, frequency of harvesting and addition of fertilisers on the yields of natural vegetation. If methanol could be produced from Pteridium yielding 8 t $ha^{-1}yr^{-1}$ with an efficiency of 50%, the equivalent of the energy in 25% of all the petrol and petroleum product deliveries in Scotland would be contained in Scotland's Pteridium resource. Farms in northern Britain could be self sufficient for energy by using natural biofuels and could market surplus requirements to generate a new source of income. Further research is required to develop optimum crop management practices and to demonstrate and cost the suitable agricultural and conversion equipment required to produce biofuels. The scheme developed to obtain solid biofuels from autumn biomass can be applied to many perennial species which naturally cover large areas of the EEC. (orig.).

31699 **(EUR—10108-EN) Photoelectrochemical systems for solar energy conversion. Final report.** McEvoy, A.J.; Meissner, D.; Etman, M.; Memming, R.; Kastening, B. (Hamburg Univ. (Germany, F.R.). Inst. fuer Physikalische Chemie). 1985. 85p. Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities.

Energy.

Within the scope of the present program we have investigated the possibility of stabilization of semiconductor electrodes. We followed two routes; in one case we tried to reduce the photo-decomposition of semiconductors by deposition of polypyrrole and in the other we loaded CdS-particles and monograin membranes with catalysts in order to promote the photo-electrochemical water clearage. With respect to polypyrrole deposited on WSe_2 or GaAs we found that the trapping of minority carriers at the interface is considerably reduced leading to more favourable photocurrent-potential dependences. It is not clear yet whether the anodic decomposition of layer compounds, such as e.g. WSe_2, can be decreased. In connection with the problem of catalyzing hydrogen and oxygen evolution at CdS particles we could demonstrate that no O_2-formation occured at CdS. It was shown that O_2 even enhanced the photo-corrosion. The monograin membrane technique was applied to investigate in detail the role of catalysts deposited on CdS using artificial electron donors. According to our results there are no specific differences between various catalysts. These observations were interpreted in terms of a Schottky barrier formed at the catalyst/semiconductor interface. The results are discussed in detail and an outlook for further research is given.

31700 **(NP—6901349) Retrospective search on biomass harvesting techniques including materials handling and storage.** (Institute for Industrial Research and Standards, Dublin (Ireland). Information Technology Group). Oct 1985. 90p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86901349.

This literature search covers the period 1977 to date. The harvesting, materials handling and storage of the following materials: wood; crops and crop residues; peat; sugar cane; reeds, grasses and fers; algae and jojoba shrubs are covered.

31701 (SERI/CP—215-2773, pp 79-88) **Photovoltaic device performance - overview.** D'Aiello, R.V. (Solarex Thin Film Division, Newtown, PA). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The emphasis in research has shifted to thin-film cells especially amorphous silicon (a-Si) based devices, and several companies in the United States as well as Japan, are now commercially producing a-Si thin-film cells and integrated modules. Although many of the measurement techniques and characterization methods discussed at previous workshops are applicable to thin-film devices, a new set of needs and concerns has arisen. Some of these although previously recognized, are now more sharply focused by recent advances in thin-film devices, while others, entirely new, are brought about by the properties of the thin-film materials comprising the cells, and by the fundamental physics of the device operation. A general overview of the progress made in photovoltaic device performance testing and characterization is presented, highlighting some new areas and differences between thin-film cells and modules and the more conventional crystalline silicon devices.

31702 (SERI/CP—215-2773, pp 91-99) **Solar simulators and I-V measurement methods.** Emery, K.A. (Solar Energy Research Institute, Golden, CO). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The illuminated current versus voltage (I-V) characteristics of a photovoltaic (PV) device typically measured with respect to standard test conditions, are defined by a spectrum, intensity, temperature and area. Factors that influence I-V measurements include: voltage sweep rate and direction, contact to the metallization, light source, junction temperature, instrumentation and intensity. The merits and problems of various procedures influencing the repeatability and accuracy of I-V data are discussed. The photovoltaic conversion efficiency is defined as 100 times the maximum power produced by the PV device divided by the incident light power under standard test conditions. A variety of solar simulators used by the PV community, which approximate a standard solar spectrum and intensity are compared using the ASTM procedure for determination of the simulator class. The spectral mismatch index can also be used to evaluate differences in the relative spectral irradiance of a solar simulator for the particular test cell/reference cell combination of interest. Several methods of enhancing the ability of solar simulators to match a given standard solar spectrum and intensity are described.

31703 (SERI/CP—215-2773, pp 103-111) **Outdoor photovoltaic device performance testing.** Mitchell, K.W.; Fabick, L.B.; Fairchild, C.E.; Woolston, T.; Canale, J.; Pyle, B.; Rumburg, J.; Willett, D. (ARCO Solar, Inc., Chatsworth, CA). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

Outdoor photovoltaic (PV) device performance testing is essential for verifying PV performance data based upon indoor testing and for measuring actual performance under operating outdoor temperature and irradiance conditions. The test facility layout is reviewed, the various measurement systems components are described, and lessons learned from establishment of the facility are summarized.

31704 (SERI/CP—215-2773, pp 115-124) **Translation of device performance measurements to reference conditions.** Osterwald, C.R. (Solar Energy Research Institute, Golden, CO). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The correction of solar cell performance measurements to standard reporting conditions are discussed. Attention is focused upon temperature coefficients and spectral corrections for short-circuit current. The formulation of temperature and spectral corrections are derived, and examples using measured data are presented to illustrate actual use. Spectral corrections are divided into reference cell calibrations and spectral mismatch calculations for the reference cell measurement method.

31705 (SERI/CP—215-2773, pp 127-135) **Photovoltaic concentrator cell measurement methods.** Gee, J.M.; Hansen, B.R. (Sandia National Lab., Albuquerque, NM). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The testing of solar cells under high irradiances introduces additional complexities not present when testing cells under one-sun illumination. Methods for testing of photovoltaic concentrator cells are discussed.

31706 (SERI/CP—215-2773, pp 139-148) **Measurement techniques for evaluation of a Si:H solar cells.** Bennett, M.S.; Arya, R.R. (Solarex Thin Film Division, Newtown, PA). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

In any photovoltaic research and/or manufacturing facility large numbers of solar cells are made which must be analyzed in a manner which is fast and simple yet comprehensive enough that the performance of the cells can be understood. The primary measurement is the current voltage characteristic under solar or simulated solar radiation. This measures the primary photovoltaic parameters - open-circuit voltage, short-circuit current, and fill factor. In order to explain the values obtained by these measurements, one must use other characterization schemes. These include quantum efficiency measurements, as well as dark diode measurements, and measurements of the light characteristic as a function of illumination intensity. By far the most powerful of these schemes is the quantum efficiency measurement. The implementation, interpretation, and limitations of the various characterization schemes are discussed.

31707 (SERI/CP—215-2773, pp 151-167) **Spectral response and I-V measurements of tandem amorphous-silicon alloy solar cells.** Burdick, J.; Glatfelter, T. (Energy Conversion Devices, Inc., Troy, MI). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

In recent years thin-film solar cells made with amorphous-silicon alloys have been shown to be a viable alternative to crystalline devices. Devices made from these materials are commonly fabricated in a single-cell type configuration. Stacking more than one of these single cells in series gives multiple-cell types called tandems. These tandem structures have been shown to have better performance than their single-cell counterparts in two key areas of photovoltaic energy conversion: high efficiency and long-term stability. How the spectral response of a two-cell tandem device, as well as its single-cell components, may be measured are discussed. It is shown that these response curves may be used as a diagnostic tool in determining such device parameters as individual layer thicknesses, current matching, and optical-absorption profile optimization of the single-cell components.

31708 (SERI/CP—215-2773, pp 171-180) **Advanced techniques for the measurement of recombination and transport parameters throughout solar cells.** Newhouse, M.A.; Wolf, M. (Univ. of Pennsylvania, Philadelphia). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

For a complete solar cell design process, all of the parameters which affect performance can be fully analyzed, and the appropriate design and processing changes determined. The most critical of these parameters are the bulk minority carrier lifetimes tau and the boundary transport velocities (at surfaces this is called surface recombination velocity(s)). Previously developed lifetime measurement methods have been directed at extracting a single bulk lifetime value from rather simple structures in which nonuniformities, multiple regions and boundary transport velocities were ignored. As these methods are no longer adequate, techniques are considered for measuring the multiple recombination parameters as a function of position in real devices.

31709 (SERI/CP—215-2773, pp 183-191) **Status of IEC, ASTM, and IEEE photovoltaic standards.** Hogan, S.J. (Spire Corp., Bedford, MA). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The importance of standard methods and practices is discussed. For the photovoltaic industry to mature in the international as well as domestic marketplace a common ground must be established. The standards being developed and implemented today will be the basis for this common ground. It is the purpose of this study to update the status of standards being developed in the United States and by the International Electrotechnical Commission (IEC), and to describe the process involved in the development of these standards.

31710 (SERI/CP—215-2773, pp 195-205) **System and module rating: advertised versus actual capability.** Taylor, R.W. (Electric Power Research Institute, Palo Alto, CA). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

It has been shown in many analyses that PV system (and hence module) efficiency is a key driver in system economics. It is, therefore, important that agreement be reached within the PV community on how to rate PV modules and systems. Information emanating from field testing indicates two important items in this regard. First, system and module nameplate ratings are virtually never achieved at generally accepted reference conditions; and second, a single-point specification of efficiency may not adequately represent the annual performance of some modules and systems. This study compares nameplate power and efficiency ratings with actual achieved performance for eight systems and six modules. It is proposed that the industry establish a new rating scheme based on actual field performance.

31711 (SERI/CP—215-2773, pp 209-216) **Characterization of photovoltaic array performance - an overview.** Ross, R.G. Jr. (Jet Propulsion Lab., Pasadena, CA). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

Over the past decade, research directed at improving the cost-effectiveness of photovoltaic arrays for terrestrial power generation has made substantial progress. One area of significant achievement is the understanding of array performance - means of determining it, and means of reporting it. The diverse demands placed on array performance data by its many uses are reviewed and the elements of performance prediction and measurement are summarized.

31712 (SERI/CP—215-2773, pp 219-228) **Photovoltaic flat-plate array and insolation measurements.** Russell, M.C.; Bergman, D.A. (MIT Energy Lab., Concord, MA). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The Massachusetts Institute of Technology operates the Northeast Regional Experiment Station (NE RES) in Concord, MA, where eight residential PV systems are under evaluation. In addition, the insolation resources of the site are being monitored to support ongoing comprehensive research of PV system performance. Ongoing work in two areas is discussed: PV array rating and off-azimuth insolation measurements.

31713 (SERI/CP—215-2773, pp 231-240) **PV concentrator array field performance measurement.** Maish, A.B. (Sandia National Labs., Albuquerque, NM). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The objective of measuring PV module, array and field performance is different from the objective of measuring cell or device performance. Device performance is measured so that incremental improvements in power and efficiency can be identified. When monitoring module, array and field performance, however, the emphasis is on characterizing subsystem performance and reliability and on obtaining data to estimate system energy production. The procedures used to measure concentrator module and array performance at Sandia National Laboratories are discussed. The method used to characterize efficiency as a function of two independent variables, direct normal insolation (DNI) and the heat sink temperature, is described. The uncertainty in the measured efficiency due to the choice of independent variables was investigated. A review of some of the factors that must be considered in a model which uses the array efficiency equation to estimate annual system energy production is presented.

31714 (SERI/CP—215-2773, pp 243-252) **Photovoltaic array loss mechanisms.** Gonzalez, C. (Jet Propulsion Lab., Pasadena, CA). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The development of an array electrical performance model is generally based on a model describing the output of the photovoltaic module being used. The latter will consist of an I-V curve defined for a given set of irradiance and environmental conditions and a set of irradiance and cell-temperature translation coefficients. After the modules are assembled into the array, loss mechanisms not accounted for when modeling the output of a module must be introduced into the array output model. These loss mechanisms can be divided into two categories. The first category includes those loss mechanisms leading to a reduction in the average array electrical performance as defined by the I-V curve. These loss mechanisms manifest themselves as changes in the array I-V curve from that of the module, either as a simple translation in the two-dimensional I-V space, or a change in the curve shape. The net result is reduced power output when measured at the maximum-power point. The second category of losses is associated with non-optimal extraction of power from the array. These mechanisms do not alter the array I-V curve, but result from an operating point different than the array maximum-power point. These loss mechanisms are discussed.

31715 (SERI/CP—215-2773, pp 255-265) **Photovoltaic array performance simulation models.** Menicucci, D.F. (Sandia National Labs., Albuquerque, NM). 1985. NTIS, PC A13/MF A01. File Number DE85012145. (CONF-8506237—).

From Photovoltaics and insolation measurements workshop; Vail, CO, USA (30 Jun 1985).

The experience of the solar industry confirms that despite recent cost reductions the profitability of photovoltaic (PV) systems is often marginal and the configuration and sizing of a system is a critical problem for the design engineer. Construction and evaluation of experimental systems are expensive and seldom justifiable. A mathematical model or computer simulation program is a desirable alternative, provided reliable results can be obtained. PV system modeling techniques were studied in an effort to develop an effective tool to be used by engineers and architects in the design of cost-effective PV systems. Two of the sources of error found in previous PV modeling programs are reviewed, the remedies developed to correct these errors are presented, and a new program that incorporates these improvements is described.

31716 **(SERI/SP—271-2763) US photovoltaic patents, 1951-1983.** (Solar Energy Research Inst., Golden, CO (USA)). Apr 1986. Contract AC02-83CH10093. 197p. NTIS, PC A09/MF A01; GPO Dep. File Number DE86004431.

This document comprises citations of 1,487 US patents on terrestrial power photovoltaic applications, systems, components, materials, manufacturing and support functions. Specifically excluded are patents on space photovoltaic technology, use of the photovoltaic effect for detectors, and subjects only peripherally concerned with photovoltaics. Citations are indexed by inventor, assignee, and subject. (LEW)

31717 **Effects of boron profiles on the open circuit voltage of p-i-n and n-i-p amorphous silicon solar cells.** Jeffrey, F.R.; Vernstrom, G.D. (E & I Sector Laboratory, 3M Center, St. Paul, Minnesota 55144). *Applied Physics Letters;* **48**: No. 22, 1538-1539(2 Jun 1986).

Data are presented showing that boron carryover into the i layer is responsible for the commonly observed difference in open circuit voltage between p-i-n and n-i-p amorphous silicon solar cells. It is proposed that the lower voltage samples are being limited by surface recombination at the p/i interface and that boron carryover reduces this recombination current. The V/sub oc/ is then able to rise to the point where it is limited by the bulk recombination current.

31718 **Three-junction solar cell.** Ludowise, M.J. (to Dept. of Energy). US Patent 4,575,576. 11 Mar 1986. Filed date 7 Nov 1984. vp.

A monolithic photovoltaic cell is described which consists of: an upper surface layer adapted for entrance of exciting light, three semiconductive layers positioned sequentially with respect to a position starting from the upper surface layer, namely an upper layer, a middle layer, and a lower layer, within each of the semiconductive layers, a photovoltaic junction, thus providing upper, middle, and lower junctions, the upper junction having a first polarity with respect to the upper surface, the middle and lower junctions having a second polarity opposite to that of the upper junction, a conductive substrate beneath the lower layer, a conductive electrode connected to the substrate, a light-permeable electrode attached to the upper surface of the upper surface layer, a high gap transparent between the middle layer and the lower layer, a first high conductivity layer between the middle layer and the hig-gap transparent layer, an aperture through the upper, middle, first high conductivity, and transparent layers, the aperture having stepped sides exposing a portion of the upper surfaces of the middle layer, the first high conductivity layer, and the lower layer, a first metallic conductor in the aperture in ohmic contact with the top of the bottom layer and in overlapping contact with the top of the first high conductivity layer, a second metallic conductor in the aperture insulated from the first conductor and in contact with the upper surface of the middle layer, and means for external electrical connections to the substrate connected electrode, the light permeable electrode, and the second conductor.

31719 An approach toward 20-percent-efficient silicon solar cells. Rohatgi, A.; Rai Choudhury, P. (Westinghouse R & D Center, Pittsburg, PA). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Electron Devices;* **33**: No. 1, vp(Jan 1986). Contract AC02-83CH10093.

This paper shows that oxide surface passivation coupled with optimum multilayer antireflective coating can provide ≈ 3 percent (absolute) improvement in solar cell efficiency. Use of single-layer ar coating, without passivation, gives cell efficiencies in the range of 15-15.5 percent on highquality 4-o . Cm as well as 0.1-0.2o . Cm float-zone silicon. Oxide surface passivation alone raises the cell efficiency to Γ 17 percent. An optimum double-layer ar coating on oxide-passivated cells provides an additional ≈5-10 percent improvement over a single-layer ar-coated cell, resulting in cell efficiencies in excess of 18 percent. Experimentally observed improvements are supported by model calculations, and an approach to Γ 20 percent efficient cells is discussed.

31720 Circuit transients due to negative bias arcs-II. Metz, R.N. (Colby College, Waterville, ME). pp 6 of AIAA, Aerospace Sciences meeting. Reno, NV; AIAA (1986). (CONF-860130—).

From 24. AIAA aerospace science meeting; Reno, NV, USA (6 Jan 1986).

Two new models of negative-bias arcing on a solar cell power system in Low Earth Orbit are presented. One is an extended, analytical model and the other is a non-linear, numerical model. The models are based on an earlier analytical model in which the interactions between solar cell interconnects and the space plasma as well as the parameters of the power circuit are approximated linearly. Transient voltages due to arcs struck at the negative thermal of the solar panel are calculated in the time domain. The new models treat, respectively, further linear effects within the solar panel load circuit and non-linear effects associated with the plasma interactions. Results of computer calculations with the models show common-mode voltage transients of the electrically floating solar panel struck by an arc comparable to the early model but load transients that differ substantially from the early model. In particular, load transients of the non-linear model can be more than twice as great as those of the early model and more than twenty times as great as the extended, linear model. 7 references.

31721 Lamp annealing of ion implanted GaAs. Miyashita, H.; Okamoto, K. *Denki Tsushin Daigaku Gakuho;* **36**: No. 1, vp(Sep 1985).

Halogen lamps are used to anneal Si implanted GaAs. SiO_2/Al_2O_3 double layered capping is proved to be more effective than the conventional SiO_2 capping. It also becomes apparent that optimal activation is established in shorter processing time for annealing of implanted side irradiation than for backside irradiation. Electron mobility in activated layers reflect the characteristics of the substrates and undoped LEC GaAs substrate shows the highest mobility of 4,120 sq. cm./V.s.

31722 Potential health and safety hazards associated with the manufacture of amorphous silicon and copper indium diselenide photovoltaic cells. Fthenakis, V.M.; Moskowitz, P.D.; Hamilton, L.D. (Biomedical and Environmental Assessment Div., Brookhaven National Lab., Upton, NY 11973). pp 547 of Proceedings of Intersol 85. Ottawa, Ontario; SESCI (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Amorphous Silicon (α-Si) and copper indium diselenide ($CuInSe_2$) are two new and promising photovoltaic cell technologies. Analysis of potential health and safety risks is required before these energy technologies become fully commercialized so that alternative strategies may be developed, engineering design costs reduced, and health risks minimized. This paper summarizes results of a study conducted at Brookhaven National Laboratory with support from the U.S. Department of Energy/National Photovoltaic Program to identify and characterize hazards related to the production of α-Si and $CuInSe_2$ photovoltaic cells.

1406 Photovoltaic Power Systems

REFER ALSO TO CITATION(S) 31676, 31716

31723 (CONF-850241—, pp 233-235) **Photovoltaic system performance model.** Borgo, P.A.; Russo, R.V. (Meridian Corp., Falls Church, VA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The Photovoltaic System Performance Model (PVSPM) was developed by Meridian Corporation to assist in the site-specific design of PV systems for various applications. The model is programmed in BASIC to run on an IBM/PC with a single disk drive and 64K of internal memory. The PVSPM consists of three submodels; a solar insolation model, a PV array performance model, and a life-cycle cost model. The PVSPM computes solar radiation on a surface at any latitude or tilt angle and uses these results to determine the output of a PV array given monthly ambient temperature, average daily hours of sunshine and clearness ratio. The cost model is interactive with the PV array performance model to facilitate sensitivity studies for cost-benefit analyses.

31724 (CONF-850241—, pp 237-246) **Photovoltaic array simulation program.** Hart, G.W.; Bergman, D.A. (Massachusetts Institute of Technology, Concord). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A computer program has been developed to simulate the dc current-voltage (I-V) characteristics of a photovoltaic array, as a function of the internal components of the array, and their wiring topology. The program can prepare plots of I-V curves, determine maximum power voltages and currents, and identify subsections of a structure that dissipate energy. The program has been found well suited for overall PV array design, determining optimal module or array diode placement, and the evaluation of mismatch losses in a module or an array.

31725 (CONF-850241—, pp 247-250) **1-MW/sub AC/ photovoltaic SMUDPY1 control and data acquisition system.** Doss, L.W. III. (Acurex Corp., Mountain View, CA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The control and data acquisition system of the Sacramento Municipal Utility District SMUD 1-MW/sub AC/ Photovoltaic (PV) Generating Plant (SMUDPV1) located near Sacramento, CA is described. Although the software itself is specific to the particular configuration of the SMUDPY1 plant, concepts and structure of the program are universally applicable to any single-axis tracking solar facility.

31726 (CONF-850241—, pp 251-255) **Photovoltaic/wind system performance programs.** Watson, G.; Hutchinson, P.A.; Wrasman, B. (Naval Civil Engineering Labs., Port Hueneme, CA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The US Navy is using alternative energy systems to provide power in certain remote locations. As the success of installed systems grows, the Naval Civil Engineering Laboratory (NCEL) is developing tools to educate field personnel in the specification and operation of these systems. To address this target group, NCEL and the New Mexico Solar Energy Institute (NMSEI) developed a program that would provide reasonable predictions of PV and/or wind energy system performance, yet could be operated by personnel more familiar with specifying diesel generators. Using the HP-87, a microcomputer available at most field locations, the PV/WIND I program was developed. This program uses Typical Mete-

orological Year (TMY) data as the resource and calculates the energy output per kilowatt installed for photovoltaics (PV) and wind systems. The only input required is monthly electrical demand. The program allows the user to add or subtract PV and wind units in increments of 100 watts or 1 kilowatt. Once a suitable match between production and demand is achieved, the user can request an estimate of the life cycle cost of the solar electric system and an equivalent size diesel generator. The information provided by these programs will give the operator a preliminary estimate of solar electric energy system performance and cost. With this type data, the user can then ask NCEL for specific system designs and more detailed simulations.

31727 (CONF-850241—, pp 257-261) **Employing a spreadsheet for photovoltaic design.** Martin, D.E.; McQueen, L. (Univ. of Kansas, Lawrence). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Photovoltaic design is a blend of technical and economic issues involving many variables. Design Handbook for Photovoltaic Power Systems by Y.P. Gupta and S.K. Young provides a method for analyzing these issues for a residential, utility connected system. Gupta and Young illustrate samples of the many calculations necessary to produce results. A method and a computer spreadsheet program yielding rapid evaluation of these issues are discussed. The effects of a single parameter change can be shown in less than 20 seconds of computing times. This approach provides easy access to useful computing capabilities without requiring programming skills. In addition, many variables such as site climate and insolation values, photovoltaic system and performance estimates of its associated power conditioning equipment, the electrical load and economic questions can be assessed. The spreadsheet and user notes are available, for a nominal duplicating fee, from the MIT Designers Software Exchange Program.

31728 (CONF-850241—, pp 263-267) **Application of spreadsheet software for photovoltaic power plant optimization.** Kuhr, R.W.; Burns, J.V. (Stone & Webster Engineering Corp., Boston, MA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The application of Lotus 1-2-3 spreadsheet software to compile and manipulate design, cost, and performance information for the Sacramento Municipal Utility District (SMUD) PV3 5 MW photovoltaic plant is described. The resulting template program provides a menu-driven, user friendly, interactive format for evaluating alternative photovoltaic array tracking configurations. IBM mainframe custom software and other Lotus 1-2-3 templates are used to develop performance information and compare results. The major advantages of using spreadsheet software include reduced programming and documentation requirements, easy adaptability to future similar applications, and the ability to quickly modify and document each plant design case studied. Future plans include refinement of the plant cost and performance models to support subsystem trade-off and optimization studies. The refined model is intended to support detailed analysis of alternate equipment suppliers to quantify cost/performance tradeoffs.

31729 (SAND—85-2136) **Design of an intermediate-sized, autonomous photovoltaic-diesel power plant.** Calloway, T.M. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010629.

A method is presented for designing an intermediate-sized, autonomous photovoltaic power plant with a diesel-electric generator and a battery bank. Energy output from the photovoltaic array first satisfies any load demand then charges the batteries. Diesel-electric generators periodically equalize battery charge and occasionally supply load demand when array output is insufficient and battery state of charge is too low to provide supplemental energy. Given hourly load demand and annual fuel consumption, battery capacity is functionally related to array size. Subsequently, a model predicts battery life by deducting the fraction of total life consumed each day. An economic model then computes life-cycle system cost. Repeating this process for different combinations of array area and battery capacity produces a curve that identifies the minimum-cost system design.

1407 Solar Thermal Power Systems

REFER ALSO TO CITATION(S) 31968

31730 (CONF-850241—, pp 105-109) **Development of a microprocessor based wind and solar monitoring system.** Haley, J.S.; Fwert, D.L. (Univ. of North Dakota, Grand Forks). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A working wind and solar monitoring system is described. By incorporating a microcomputer into the data acquisition system, the resulting system offers greater flexibility in method of data acquisition. Also, some of the statistical data reduction can be done while acquisition is taking place, thus lessening the task of data manipulation at a later date. A modular acquisition system was chosen that consists of a baseboard and selected modules. One module provides a number of input channels for higher level signals (0-10 VDC). Another module provides input channels for low level signals (0-100 mV). Each module provides software selectable signal amplification. Data is required every two seconds continuously, 24 hours a day. At present, the 5-1/4" disks containing data are hand delivered weekly from the remote monitoring site to the University, where the data is then uploaded to the University's mainframe computer for statistical analysis and permanent storage on tape. Future plans include establishing a telecommunications link to the monitoring site to eliminate the need for hand delivery of the data on a weekly basis.

31731 (DOE/JPL—1060-87) **Publications of the JPL Solar Thermal Power Systems Project, 1976-1985.** Panda, P.; Gray, V.; Marsh, C. (comps.). (Jet Propulsion Lab., Pasadena, CA (USA)). 1 Sep 1985. Contract AI04-80AL13137. 88p. (JPL-PUB—85-52). NTIS, PC A05/MF A01; GPO Dep. File Number DE86010240.

The bibliographical listings in this publication are documentation products associated with the Solar Thermal Power Systems Project carried out by the Jet Propulsion Laboratory from 1976 to 1986. Documents listed herein are categorized as conference and journal papers, JPL external reports, JPL internal reports, or contractor reports (i.e., deliverable documents produced under contract to JPL). Alphabetical listings by title were used in the bibliography itself to facilitate location of the documents subject. Two indexes are included for ease of reference: one, an author index; the other, a topical index.

31732 (SAND—86-0289C) **Heat engine development for solar thermal dish-electric power plants.** Linker, K.L. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 16p. (CONF-860655—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009377.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

The Department of Energy's (DOE) Solar Thermal Program has as one of its responsibilities the development and evaluation of heat engine technologies which are applicable to Distributed Receiver Systems. The primary research and development activities, for the past several years, have involved the so-called dish-electric concept in which a heat engine, solar receiver, and generator are coupled and located at the focus of a parabolic dish concentrator. Power conversion assemblies (PCA) would be deployed at the size of about 25 to 50 kWe which is consistent with concentrator development in the 11-15m diameter range. This report will outline the status of heat engine development, present test data and performance evaluations from experimental work to date, and discuss the strategy for future development efforts.

31733 **(SAND—86-0295C) Design and performance predictions of the DOE small community solar experiment at Osage City, Kansas.** Rush, E.E. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 5p. (CONF-860655—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009624.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

To gain system-level operating experience, the Department of Energy, through cost-shared cooperative agreements with industry is sponsoring the design, construction, and operation of two 100 kWe dish-electric solar thermal power plant field experiments. The first of these will be located at Osage City, Kansas, and is currently in the final design and prototype operation phase. The solar plant, being designed by Barber-Nichols Engineering, will incorporate four power modules, each consisting of a parabolic dish concentrator by Power Kinetics, Inc., and a 25 kWe organic Rankine cycle turbine/alternator by Barber-Nichols. Included in this presentation will be a description of the system design with particular emphasis on the concentrator, receiver, and power conversion assembly; a discussion of the issues and tradeoffs involved in the design and operation of dish-electric systems; the results of module performance verification testing being conducted at Sandia National Laboratories' Distributed Receiver Test Facility in Albuquerque; and finally performance predictions for the 100 kWe Osage City plant and for future solar energy power plants of this type.

31734 **(SERI/TP—252-2903) Rapid heating of gas/small-particle mixture.** Wang, K.Y.; Yuen, W.W. (Solar Energy Research Inst., Golden, CO (USA); California Univ., Santa Barbara (USA). Dept. of Mechanical and Environmental Engineering). Feb 1986. Contract AC02-83CH10093. 9p. (CONF-860612—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86004434.

From 4. AIAA/ASME thermophysics and heat transfer conference; Boston, MA, USA (2 Jun 1986).

The concept of using a mixture of particles and air as a medium to absorb radiative energy has been proposed for various applications. In this paper, carbon particles mixed with gas form a medium that absorbs radiation from sources such as concentrated solar energy. A single-particle, two-temperature model is used to study the transient temperature of the particle/gas mixture as it undergoes a constant pressure expansion process. The results indicate that for particles smaller than 1 μm in diameter, the surrounding air can be heated as quickly as the particles, while for particles larger than 1 mm in diameter, the air temperature stays relatively unchanged and the particles are heated to a very high temperature. The effect of scattering from the particles is also examined, revealing that such a contribution is insignificant for small particles.

31735 **A solid particle central receiver for solar energy.** Hruby, J.M.; Steele, B.R. (Sandia National Labs., Livermore, CA). *Chemical Engineering Progress;* **82**: No. 2, vp(Feb 1986).

Solar central receiver systems utilize mirrors to reflect and focus the sunlight onto a receiver that resides on top of a centrally located tower. By redirecting the sunlight in this manner, the solar flux at the receiver surface can be equivalent to hundreds of suns. A working fluid in the receiver is heated by absorbing the solar radiation. This fluid can then be used to produce electricity or incorporated into products as process heat. Currently, the working fluids in a solar central receiver are gases or liquids that flow through tubes heated by the solar radiation. An example of such a system is the water/steam central receiver system located near Barstow, California, which produces electrical energy. Other common working fluids include molten salts, molten metals, and air. A novel concept for a central receiver currently being examined employs sand-size refractory particles that freefall in a cavity receiver. A conceptual design of a solid particle receiver is shown. The solid particle central receiver is being evaluated for high-temperature (greater than 550°C) applications of solar energy. The advantages of a solid particle receiver over traditional fluid-in-tube receivers are: 1) the particles can directly absorb solar radiation and 2) the particles maintain their integrity at high temperatures. These advantages, coupled with the possibility that the particles can serve as the storage medium, could provide a cost-effective means of high-temperature solar energy utilization. High temperatures are attractive for fuels and chemicals production, industrial process heat applications, or Brayton cycle electricity generation.

31736 **Progress in solar thermal distributed receiver technology.** Leonard, J.A.; Otts, J.V. (Sandia National Lab., Albuquerque, NM). *Energy Technology (Washington, D.C.);* **12**: 1622-1631(Aug 1985). (CONF-850301—). Contract AC04-76DP00789.

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The author reports the status of research on distributed receivers, which are solar thermal collectors which concentrate sunlight on an absorber and do not employ the central receiver concept. Point-focusing collectors such as the parabolic dish, line-focusing collectors such as the parabolic trough, and the fixed-mirror distributed-focus of hemispheric bowl collectors are the most common receivers. Following an overview of fundamental principals, there is a description of several installations and of the organic Rankine Cycle engine and the Solarized Automotive Gas Turbine projects. Future development will explore other types of power cycles, new materials, and other components and designs. 5 references, 6 figures.

31737 **Status of the US; solar central receiver program.** Skinrood, A.C. (Sandia National Labs., Livermore, CA). *Energy Technology (Washington, D.C.);* **12**: 1632-1640(Aug 1985). (CONF-850301—). Contract AC04-76DP00789.

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The DOE central receiver development program examines various technology options. There are two basic configurations: solar stand-alone and hybrid solar-fossil, which increases the plant's operational flexibility and extends hours of operation. In both configurations, heat transport fluids deliver the thermal energy from the receiver to the electric power generation system or the industrial process. An advantage of solar central receiver systems is that the heat transport fluid can be matched to the end use. Five fluids have been studied in some detail: water-steam, heat transfer oil, liquid sodium, molten salt, and gas (air or helium). New approaches using solid particles to transport heat are under development. The author reviews the current status of these technologies and their applications. 6 figures, 2 tables.

1409 Solar Thermal Utilization

REFER ALSO TO CITATION(S) 32043, 32067, 32087

31738 **(CONF-850241—, pp 39-43) Use of microcomputers for performance evaluation of residential buildings.** Frey, D.J.; Holtz, M.J. (Architectural Energy Corporation, Westminster, CO). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The use of a microcomputer based data acquisition system made it possible for the Solar Energy Research Institute (SERI) to monitor the performance of a large number of passive solar residential buildings in numerous locations around the US from 1981 through 1983. This work was performed in the Residential Class B Passive Solar Performance Evaluation program. The data acquisition system used was the PDL-24 manufactured by Aeolian Kinetics of Providence, Rhode Island. The PDL-24 is based on the Rockwell AIM-65 microcomputer, and was used to collect data, calculate building performance, print results on-site, and store data on cassette tape. This monitoring program is significant because it was the first large scale building performance evaluation activity which relied entirely on microcomputer technology for data acquisition and analysis.

31739 (CONF-850241—, pp 55-61) **Microprocessors based hot wire anemometry system for measuring convection air movement within the CSU Class A passive solar test facility.** Armstrong, P.R.; Heermann, P.D. (Colorado State Univ., Fort Collins). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A 60 channel velocity probe system has been developed to study interzonal convective heat transfer and boundary layer flow in the CSU class A passive solar test building. Two probes have been developed: a dual thermistor probe and a cylindrical paper probe coated with an electrically conducting film. The diameter of the latter has been optimized to maximize the forced convection component of the surface heat transfer coefficient thereby maximizing probe signal-to-noise ratio. Scanning of the probes is controlled by a Z80 based control microcomputer developed for this project. The computer also performs temperature compensation and linearization of the probe signals in software. Use of the control microcomputer allows continuous sampling and integration of interzonal flow rates over any desired time interval. This relieves the host computer of these time-critical tasks.

31740 (CONF-850241—, pp 65-70) **Development of an evaluation method for passive solar design tools.** Willman, A.J. (American Consulting Engineers Council, Washington, DC). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Over the past several years, the DOE Passive Solar Energy Program has produced a number of new methods (or tools) for analyzing passive solar heating, cooling and daylighting strategies for both residential and commercial applications. Private researchers and designers have expanded upon this work by developing methodologies of their own. However, the results of the efforts by both private and public sector research in design tool development has been accepted at a slow pace by the building design industry. The reasons for this slow infiltration are discussed. The purpose of this work was to develop a systematic procedure for investigating, evaluating and reporting on the capabilities of a design tool relative to a user's needs and criteria. The definition of a design is any device which assists the user in formulating and/or evaluating energy efficient strategies for buildings (new or existing).

31741 (CONF-850241—, pp 193-200) **Skyline Plot Program.** Quadrel, R. (Rensselaer Polytechnic Institute, Troy, NY). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The development of solar strategies in building design is primarily dependent on the building's access to the sun. In both urban and suburban conditions, this access may be prevented by obstacles such as surrounding buildings and trees. The Skyline Plot Program is an interactive computer program that allows a designer to plot these obstacles against a solar path diagram. The resulting skyline plot shows the times of the year when a given reference point may or may not receive solar radiation. The computer program permits the user to quickly modify building conditions, and to test solar access at various locations on a site.

31742 (CONF-850241—, pp 219-226) **Solar collector positioning and orientation.** Hatfield, J.M. (Northern Arizona Univ., Flagstaff). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Design calculations for placement of non-tracking flat panel solar collectors involve determination of the angular orientation of the collector toward the sun and determination of the spacing between collectors if several are to be installed. These calculations are straight forward for installations on a flat roof or on a sloping one with approximately southern exposure, but as the orientation of the roof departs significantly from south, the design becomes more complex. A computer program that facilitates design for optimum collector alignment and maximum solar gain for virtually any roof orientation or pitch is presented and performance comparisons for deviations from that nominal design are provided.

31743 (CONF-850241—, pp 227-229) **Active solar energy system design using microcomputer-based models.** Stine, W.B. (California State Polytechnic Univ., Pomona). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

For active solar energy system design, something is needed between rules-of-thumb design and a detailed mainframe oriented model. The Developmental System Model fills this need. It uses the microcomputer as it is intended, i.e., for programming, running the program and then modifying it. The important aspects of a Development System Model are to start with a simple algorithm, check the results to see if the design makes sense, and then add complexity as needed. SIMPLESYS is such a model and can be used for the design of solar energy systems. The design ratios Actual Displacement, Design Displacement, and Utilization are calculated by this model and provide the parameters to describe an optimum system design.

31744 (CONF-850241—, pp 347-353) **DHC: a diurnal heat capacity program for microcomputers.** Balcomb, J.D. (Los Alamos National Lab., NM). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Diurnal heat capacity is a useful parameter for estimating the temperature swing to be expected in a direct gain passive solar building. This is important to know because a common problem in these buildings is excessively large swings due to an inadequate amount of heat storing thermal mass within the space. The DHC program calculates the diurnal heat capacity for any combination of homogeneous or layered surfaces using closed-form harmonic solutions to the heat diffusion equation. The theory is described, a basic program listing is provided, and an example solution printout is given.

31745 (CONF-850241—, pp 355-358) **Passive solar design: SUPERCALC performs SLR.** McQueen, L.V.; Martin, D.E. (Washburn Univ. of Topeka, KS). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Evaluation of the passive solar heating design for a residential structure is a complex thermodynamic problem, involving many variables. Well-documented work by Balcomb, et al, provides the solar community with the solar load ratio (SLR) method for quickly analyzing different options. However, many hand calculations are needed to produce detailed month-by-month results. This paper will discuss a method of producing estimates and graphs of monthly solar savings fractions using a CP/M-based electronic spread sheet program, and will show how to integrate either program input or output with a word processor or data base program. This work is based on Passive Solar Design Handbook, Volume 2. This approach replaces tedious with rapid calculations, and should enhance communication between solar designers and their clients. The computer templates are available for a nominal duplicating fee.

31746 (CONF-850241—, pp 359-362) **Circuit theory approach to modeling passive solar structures.** Stearns, B. (Rochester Institute of Technology, NY). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The performance of a passive solar structure is modeled by converting the thermal parameters of the structure into electrical parameters. The structure is reconfigured as an electrical network and the circuit is solved to find the heat flux and temperature varia-

tion as a function of time. An unvented Mass Wall is modeled as a transmission line, providing a phase shift and attenuation of the heat flux generated by the radiation of the sun. The ambient temperature is modeled as an equivalent voltage source, with both a DC and diurnal frequency component, and the earth temperature is modeled as a steady DC voltage source. The results obtained are examined in an attempt to gain insight and simplify the design of a passive solar structure.

31747 (CONF-850241—, pp 363-365) **Solar sun space.** Van West, W.M. May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The economic feasibility of converting balconies to solar sun-space additions or the addition of a greenhouse was examined in this copyrighted menu driven computer program written in BASIC for the Commodore 64 or the Apple microcomputer. Cost projections, solar energy gained, pay-back period and graphic representation of data can be generated for 52 selected cities.

31748 (CONF-850241—, pp 367-375) **SDA/ONE: heat load analysis.** Bjornson, S. (Solar Design Associates, Cedar Rapids, IA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

SDA/ONE was conceived to allow a designer to implement the many what-if decisions related to passive solar design. Once basic building information is entered, the user can change any variables and recalculate a complete energy load scenario. The program was designed to be utilized on any spreadsheet type software. In my case, Lotus 1-2-3 software on a Digital Rainbow 100 with an LA 100 Letterprinter. Energy load analysis is based on ASHRAE fundamentals, and the passive solar analysis derived from Los Alamos National Laboratory research. SDA/ONE has two printing configurations, Designer (printed in draft mode and includes all building details) and Client (printed in letter mode and contains summary information used in presentation). The program is completely menu driven via the use of macro commands.

31749 (CONF-8212111—Summ.) **Energy efficiency of solar systems. Exchange of experience and information between research and industry. Proceedings.** Suter, J.M.; Keller, J. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). 1983. 103p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752011.

From Energy efficiency of solar systems meeting; Brugg-Windisch, Switzerland (9 Dec 1982).

The proceedings volume contains summaries of 13 of 17 papers read at the symposium 'Energy efficiency of solar systems'. Only solar systems with liquid heat carriers were considered. Apart from a description of individual plants (design, dimensions, measured results), fundamental studies are presented, e.g. K-value measurements on bare-tube and finned-tube heat exchangers, energy requirements of different heating boilers used as auxiliary heating systems, and simulation models. Results of the experts' discussion are presented. (BWI).

31750 (DOE/CS/30130—T1) **Application of solar energy to agricultural production processes. Final report.** (Agricultural Research Service, Tifton, GA (USA). Southern Agricultural Energy Center). [1986]. Contract AI01-79CS30130. 485p. NTIS, PC A21/MF A01; 1; GPO Dep. File Number DE86009073.

The presentations in this report were a result of research and development projects funded and managed by Interagency Agreements between the Department of Energy and the Department of Agriculture. The performing institutions were selected on the basis of peer reviews of invited and/or unsolicited proposals. During the time period covered, approximately 9 years, hundreds of technical reports and presentations have been made. The audience for these reports has included other researchers, manufacturers, sales people, contractors and end users of the information. As a result, thousands of installations have been made. Some of these have been highly successful, while others have been less successful, and some have failed. Nevertheless, these projects have shown areas where solar energy can be profitably applied to replace non-renewable forms of energy for agricultural production; areas where the use of solar energy is marginal; and areas where the use of solar energy is not profitable with current costs of non-renewable energy.

31751 (DOE/TIC—11105) **Project SAGE. Solar assisted gas energy.** (Southern California Gas Co., Los Angeles (USA)). Mar 1980. 219p. NTIS$17.00.

About 30% of southern California's energy consumption goes to residential water heating. Consequently, Southern California Gas Co., expanded a research program to examine the problems of introducing solar energy into the US building industry - on solar-assisted gas energy (SAGE) as applied to residential water heating. By mid-1974, the Jet Propulsion Laboratory had selected the most cost-effective configuration for the SAGE system, developed specifications, and identified suppliers for all components; the program then set up a demonstration apartment building equipped with rooftop collectors. The most recent phase of the project (1975-80) involved (1) field installations and evaluations of new vs. retrofit units, (2) an assessment of the market potential of the SAGE water-heating system, and (3) a policy analysis of strategies that would contribute to the widespread use of SAGE water heating. The results of this work are presented. The project analysis pinpointed the need to inform builders, architects, and plumbing contractors of the practical potential of SAGE systems.

31752 (LA-UR—86-1251) **Passive space heating with a self-pumping vapor system.** Hedstrom, J.C.; Neeper, D.A. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-860655—7). NTIS, PC A02. File Number DE86010178.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

In this system, which should be useful for space or water heating, a refrigerant is evaporated in a solar collector and condensed within thermal storage located in the building below the collector. The vapor pressure generated in the collector periodically forces the condensed liquid upward to the location of the collector. This paper reports results of an operational test, in which this system provided passive space heating for an outdoor test cell during a winter season. The daily average energy yield and the elevation of collector temperature caused by self-pumping are reported, as well as observations on failure modes, system reliability, and suggestions for a practical configuration.

31753 (LA-UR—86-1349) **Generalized solar load ratio correlation for direct gain buildings.** Wray, W.O.; Best, E.D. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 7p. (CONF-860655—9). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010191.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

A generalized solar load ratio correlation has been developed for direct gain buildings by generating relationships between the correlation parameters and two fundamental design parameters. The first design parameter is the steady state conductance of the solar aperture, U/sub c/. The second is the effective heat capacity of the solar zone, EHC.

31754 (PB—86-168796/XAB) **Passive solar/gas technology characterization and development. Final report, December 1982-March 1985.** Burns, P.J.; Kirkpatrick, A.T.; Winn, C.B. (Colorado State Univ., Fort Collins (USA). Dept. of Mechanical Engineering). Aug 1985. 141p. NTIS, PC A07/MF A01.

The report presents the methodology to: (1) accurately determine annual energy usage for passive-solar buildings; (2) balance the amounts of auxiliary energy, passive-solar features, and conservation (levels of insulation); and (3) size zone-heating radiant panel

units for passive-solar buildings. The methodology focuses upon the building as a system with a life cycle-costing approach encompassing capital-equipment costs, installation costs, and energy costs. Thus, a comparison of gas versus electric systems is possible which includes these effects. The manual includes about 50 different types of passive solar systems in about 50 different locations across the continential United States.

31755 **(SERI/TP—250-2928) Energy Signatures: a proposed new design tool.** Balcomb, J.D. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1986. Contract AC02-83CH10093. 7p. (CONF-860655—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86004446.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

Energy Signatures is a proposed new technique for aiding a designer in selecting and sizing passive solar elements on a building. Hourly heat flux profiles for each candidate design element are determined. These profiles are then matched to the hourly energy requirement of the space accounting for weather conditions, internal heat profiles of the space, and the mass characteristics of the building. Simulation analysis techniques are used to determine the Energy Signatures, the load profiles, and check the final result. Least-squares techniques are used to determine the optimum mix of strategies. Examples are given to illustrate development of the method up to the present. Future directions and possibilities are outlined.

31756 **(SERI/TP—250-2934) Passive solar in China: traditional and new.** Balcomb, J.D.; Balcomb, S.A. (Solar Energy Research Inst., Golden, CO (USA); Balcomb (Sara A.), Golden, CO (USA)). Apr 1986. Contract AC02-83CH10093. 7p. (CONF-860655—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86004452.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

The authors' observations of a tradition of passive solar architecture in northern China are described. Tendencies for modern buildings to depart from this tradition are noted. Major passive solar research programs are discussed and experimental buildings are illustrated. It is concluded that the Chinese could realize a major advantage by combining their strong tradition of passive solar architecture with modern insulation methods and improved glazing systems.

31757 **(SERI/TP—252-2943) Energy transport using natural convection boundary layers.** Anderson, R. (Solar Energy Research Inst., Golden, CO (USA)). Apr 1986. Contract AC02-83CH10093. 5p. (CONF-860655—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86004454.

From American Solar Energy Society annual meeting and 11. national passive solar conference; Boulder, CO, USA (8 Jun 1986).

Natural convection is one of the major modes of energy transport in passive solar buildings. There are two primary mechanisms for natural convection heat transport through an aperture between building zones: (1) bulk density differences created by temperature differences between zones; and (2) thermosyphon pumping created by natural convection boundary layers. The primary objective of the present study is to compare the characteristics of bulk density driven and boundary layer driven flow, and discuss some of the advantages associated with the use of natural convection boundary layers to transport energy in solar building applications.

31758 **The gap between active and passive solar heating.** Balkoub, J.D. (Los Alamos National Lab., Los Alamos, New Mexico 87545). pp 11-17 of Proceedings of Intersol 85. Ottawa, Ontario; SESCI (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

The gap between active and passive solar could hardly be wider. The reasons for this are discussed and advantages to narrowing the gap are analyzed. Ten years of experience in both active and passive systems are reviewed, including costs, frequent problems, performance prediction, performance modeling, monitoring, and cooling concerns. Trends are analyzed, both for solar space heating and for service water heating. A tendency for the active and passive technologies to be converging is observed. Several recommendations for narrowing the gap are presented.

31759 **Heat distribution by natural convection.** Balcomb, J.D. (Los Alamos National Lab., Los Alamos, NM 87545). pp 67 of Proceedings of Intersol 85. Ottawa, Ontario; SESCI (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Natural convection plays the major role for distribution of heat in many passive solar buildings, especially those that employ sunspaces or atria as a solar heat collection element. Another example is a single remote room on the north side of the building heated by natural convection through a doorway. This convective exchange usually involves normal architectural elements such as doorways, hallways, rooms, and stair-ways. Los Alamos has measured data in 15 different building geometries to thoroughly understand this complex process. Detailed measurements of air velocity and temperature have been used to determine airflow and energy transfer rates. Similitude experiments have been performed in the laboratory. The authors have found that large natural convective exchanges occur with modest temperature differences and that one often finds a major convective loop around the passages of a two-story geometry. They find that building geometry and aperture sizes have a major influence on both energy exchange rates and thermal comfort and that stratification and convective exchange are closely coupled phenomena. The paper describes these experiments and the most important findings. Simple relationships have been developed to predict energy exchange rates in particular situations, and these have been confirmed based on the experimental observations. These relationships are then used to develop design charts and graphs suitable for use in the lay-out of buildings.

31760 **A self-pumping vapor system for hybrid space heating.** Neeper, D.A.; Hedstrom, J.C. (Los Alamos National Lab., MS/J576, Los Alamos, NM 87545). pp 102 of Proceedings of Intersol 85. Ottawa, Ontario; SESCI (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

This paper reports the development of a passive system that transports heat from a solar collector downward. Refrigerant is evaporated in a collector, and the vapor transports heat to one or more condensers located at some arbitrary elevation below the collector. The vapor pressure lifts the liquid from the condenser to an accumulator above the collector, from which it periodically flows by gravity into the collector. This system has several unique advantages: (1) a lower rate of mass circulation than would be required by circulation of liquid only, (2) elimination of pumps and controllers, (3) simple control by a manual shut-off valve when heat is not needed, and (4) collection remote from thermal storage. Although useful for heating of service water, vapor transport is attractive for space heating because (in principle) any number of physically separate passive thermal storage units can be connected in parallel. The vapor will preferentially condense in the unit of lowest temperature, thereby tending to maintain separate zones of the building at the same temperature. The authors have investigated the theory of a selp-pumping vapor transport system, and have tested such systems experimentally in a space heating mode.

1410 Solar Collectors And Concentrators

REFER ALSO TO CITATION(S) 31733, 31742, 31752

31761 **(BMFT-FB-T—85-155) Development of new absorber coatings for high temperature applications. Final report.** Tihanyi, B.A. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 117p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752006.

Development, preparation and testing of coating chemicals, in particular metal carbonyls and salts of carboxylic acids. Development of solar selective absorber systems utilizing the techniques

used in catalyst manufacture (cementation, precipitation) and topochemical processes (spray coating, pyrolysis) for the temperature range 400-700°C. Two coatings fulfill the aim requirements; test coating of pipe section was carried out with one of the systems. (orig.). With 11 refs., 28 tabs., 62 figs.

15 GEOTHERMAL ENERGY

REFER ALSO TO CITATION(S) 31990, 31991

1501 Resource Status And Assessment

31762 **(DOE/SF/15134—T1) Geothermal resource evaluation of the Yuma area.** Poluianov, E.W.; Mancini, F.P. (Arizona Solar Energy Research Commission, Phoenix (USA)). 29 Nov 1985. Contract FG03-84SF15134. 228p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE86009444.

This report presents an evaluation of the geothermal potential of the Yuma, Arizona area. A description of the study area and the Salton Trough area is followed by a geothermal analysis of the area, a discussion of the economics of geothermal exploration and exploitation, and recommendations for further testing. It was concluded economic considerations do not favor geothermal development at this time. (ACR)

1503 Geothermal Exploration And Exploration Technology

REFER ALSO TO CITATION(S) 32353

31763 **(DOE/ID/12079—130) Analysis of temperature-time data from 3 m drillholes at Crystal Hot Springs, Utah.** Howell, J.; Chapman, D.S. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). 1986. Contract AC07-79ID12079. 57p. (ESL—86006-TR). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86009899.

A method for determining the background geothermal gradient values through the analysis of temperature measurements at multiple depths to 3 m and recorded over a time span of several days is presented. The analysis is based on the amplitude decay and phase shift of temperature waves with depth. Diurnal and other high frequency temperature variations are used to compute thermal diffusivities which in turn are used to model and remove the effect of the annual temperature wave. The analysis considers both a homogeneous half space and a two layer medium consisting of an overburden of finite thickness overlying a semi-infinite substratum. The method was tested in three holes in the Crystal Hot Springs geothermal field. Temperatures in each hole were recorded once a minute over a period of three days with a probe containing thermistors at eight different depths. Five of the thermistors were positioned at shallow depths ($\leqq$ 0.5 m) to monitor diurnal and other high frequency waves and three at greater depths ($\geqq$ 1 m) to measure lower frequency variations. Since measurements were recorded at only three sites, the accuracy and reliability of the method is not fully evaluated. Potential problems to the method resulting from inaccurate model parameters and convective heat transport are investigated.

1504 Legal And Institutional Aspects

31764 **(DOE/RA/35017—T2) Constraints to leasing and development of federal resources: OCS oil and gas and geothermal. Final report.** (ICF, Inc., Washington, DC (USA)). Jan 1982. Contract AC01-79RA35017. 86p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86009301.

Chapter I identifies possible technological, economic, and environmental constraints to geothermal resource development. Chapter II discusses constraints relative to outer continental shelf and geothermal resources. General leasing information for each resource is detailed. Chapter III summarizes the major studies relating to development constraints. 37 refs. (PSB)

1508 Geothermal Power Plants

31765 **(DOE/NV/10355—1) Thermodynamic analysis of a geopressured geothermal hybrid wellhead power system. Final report.** Chang, I.; Williams, J.R. (Prairie View A and M Univ., TX (USA)). 1985. Contract AS08-83NV10355. 72p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86009409.

This research project is designed to evaluate the performance and operating characteristics of hybrid power cycles applied to geopressured and geothermal resources. The power systems evaluated are from the EPRI geopressured wellheat project and data used for the analysis are from the Pleasant Bayou well site. Three types of hybrid power systems are analyzed thermodynamically. They are (A) the single flash system, (B) the double flash system, and (C) the binary system. The studies of the first two systems are more extensive than the third one, although the binary system is the one chosen for testing at the Pleasant Bayou well site.

1509 Geothermal Engineering

31766 **(LBL—21112) Effects of non-condensible gases on fluid recovery in fractured geothermal reservoirs.** Bodvarsson, G.S.; Gaulke, S. (Lawrence Berkeley Lab., CA (USA)). Feb 1986. Contract AC03-76SF00098. 22p. (CONF-8604136—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009908.

From Society of Petroleum Engineers regional meeting; Oakland, CA, USA (2 Apr 1986).

Numerical simulations are performed in order to investigate the effects of noncondensible gases (CO_2) on fluid recovery and matrix depletion in fractured geothermal reservoirs. The model used is that of a well producing at a constant bottomhole pressure from a two-phase fractured reservoir. The results obtained have received a complex fracture-matrix interaction due to the thermodynamics of H_2O-CO_2 mixtures. Although the matrix initially contributes fluids (liquid and gas) to the fractures, later on, the flow directions reverse and the fractures backflow fluids into the matrix. The amount of backflow depends primarily upon the flowing gas saturation in the fractures; the lower the flowing gas saturation in the fractures the more backflow. It is shown that the recoverable fluid reserves depend strongly on the amount of CO_2 present in the reservoir system.

31767 **(LBL—21249) Preliminary studies of two-phase effects on pressure transient data.** Cox, B.L.; Bodvarsson, G.S. (Lawrence Berkeley Lab., CA (USA)). Mar 1986. Contract AC03-76SF00098. 10p. (CONF-860111—8). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009950.

From 11. workshop on geothermal reservoir engineering; Stanford, CA, USA (21 Jan 1986).

In this paper we perform scoping calculations on the effects of two-phase zones on well pressure transients. Three different cases are considered. The first is that of a fully two-phase system (e.g. Krafla, Iceland). Some of the complexities of this type of system are discussed. The second problem is that of a single-phase liquid reservoir with a localized two-phase zone. Possible field examples include Cerro Prieto, Mexico and Baca, New Mexico, USA. We investigate the pressure transients in a well located near an isolated two-phase zone in a single-phase liquid reservoir, and compare them to type curves based upon the constant pressure approximation. The third problem considered is that of a two-phase layer overlying a single-phase liquid layer. One example of such a reservoir is the Svartsengi geothermal field in Iceland. The numerical code MULKOM is used to simulate the three cases.

31768 **The sizing of a hot dry rock reservoir from a hydraulic fracturing experiment.** Zyvoloski, G. (Los Alamos National Lab., NM). pp 355-362 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—).

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

Hot dry rock (HDR) reservoirs do not lend themselves to the standard methods of reservoir sizing developed in the petroleum industry such as the buildup/drawdown test. In a HDR reservoir the reservoir is created by the injection of fluid. This process of hydraulic fracturing of the reservoir rock usually involves injection of a large volume (5 million gallons) at high rates (40BPM). A methodology is presented for sizing the HDR reservoir created during the hydraulic fracturing process. The reservoir created during a recent fracturing experiment is sized using the techniques presented. This reservoir is then investigated for commercial potential by simulation of long term power production.

1510 Direct Energy Utilization

REFER ALSO TO CITATION(S) 32353

1520 Geothermal Data And Theory

REFER ALSO TO CITATION(S) 31555

17 WIND ENERGY

1701 Availability (climatology)

31769 **(BMFT-FB-T—85-146) Simultaneous wind speed measurements - in different altitudes with high time resolution for the specification of large wind energy converters. Final report.** Obermair, G.; Berberich, K.; Obermair, R. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 154p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE86752014.

The specification of large wind turbines with respect to stactic and dynamic stresses and to all control and regulation systems requires time series data on the actual wind field with a time resolution of approx.=1 second and from the relevant heights of operation, including extreme values and space-time-correlations. Two high radio towers, both cylindrical and 1.50 m in diameter, were used as carriers for the instruments. For the coastal station Aurich we measured at 85 m, 123 m, 196 m about 50,000 one minute averages and 400,000 one second values, for the inland station Keilberg at 46 m, 96 m, 191 m about 80,000 one minutes averages and 200,000 one second values. Models and criteria have been developed to produce statistical data of the space-time structure of the horizontal wind field. A first class of results is local in space and time, i.e. one point measurements: velocities, directions, acceleration, direction changes. A second class of results involves to different points in time and/or space, i.e. gust factors, autocorrelations etc. Velocity and direction gradients, statistical distributions and finally the full space/time correlation functions involving data from two different space and time points. Finally the results of the measurements where used to describe the simulation of a real wind power plant with respect to accelerations, changes in accelerations, gust factors and distributions of the relevant measures. (orig.). With 13 refs., 53 tabs., 66 figs.

1703 Regulations

31770 **(CONF-8604109—4) Local planning and the electric power industry: lessons from the San Gorgonio Pass.** Throgmorton, J.A. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010501.

From Pacific Gas and Electric (PG&E) energy expo; Oakland, CA, USA (29 Apr 1986).

The electric power industry is changing in significant ways, but the role of local planners in guiding that change has not yet been clearly articulated. This article seeks to clarify that role by reporting and interpreting what happened in Palm Springs, California, when local planners confronted intense wind energy development pressure. There, local planners constrained development because the local structure of electric power supply did not permit the risks and benefits of wind energy development to be allocated in a manner that local residents considered fair. Development could have been less constrained if local planners had diverged from their traditional role as land use regulators and instead explored alternative local electric power structures.

1706 Wind Energy Engineering

REFER ALSO TO CITATION(S) 31726, 31730, 32462

31771 (CONF-850241—, pp 215-218) **Wind energy system performance model.** Borgo, P.A.; Russo, R.V. (Meridian Corp., Falls Church, VA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The Wind Energy Systems Performance Model (WESPM) was developed by Meridian Corporation for the Puerto Rico Office of Energy. The model is programmed in BASIC to run on an IBM/PC with a single disk drive and 64 K of internal memory. The WESPM consists of three separate models; the Wind Resource Model, the Wind Turbine Performance Model, and the Wind System Cost Model. The WESPM compares actual measured wind data to a Raleigh distribution and accepts manufacturer turbine performance data or assumes a quadratic approximation based on turbine characteristics. The cost model is interactive with the turbine performance model to facilitate sensitivity studies for cost-benefit analyses.

31772 **(DOE/ER/30075—H1) Wind turbine aerodynamics research needs assessment.** Stoddard, F.S.; Porter, B.K. (Washington Consulting Group, Inc., DC (USA)). Jan 1986. Contract AC01-85ER30075. 143p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86009189.

A prioritized list is developed for wind turbine aerodynamic research needs and opportunities which could be used by the Department of Energy program management team in detailing the DOE Five-Year Wind Turbine Research Plan. The focus of the Assessment was the basic science of aerodynamics as applied to wind turbines, including all relevant phenomena, such as turbulence, dynamic stall, three-dimensional effects, viscosity, wake geometry, and others which influence aerodynamic understanding and design. The study was restricted to wind turbines that provide electrical energy compatible with the utility grid, and included both horizontal axis wind turbines (HAWT) and vertical axis wind turbines (VAWT). Also, no economic constraints were imposed on the design concepts or recommendations since the focus of the investigation was purely scientific.

31773 **(GKSS—85/E/42) Pellworm-test facilities for wind energy converters. Final report of the project 'Comparative investigations of the performance of small wind energy conversion systems'.** Fries, S.; Petersen, G.; Mengelkamp, H.T. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). 1985. 132p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752030.

During the years 1980-1984 10 different wind energy converters of about 10 kW were investigated by GKSS, utilizing a test field at the island of Pellworm. The final report contains a description of the experimental devices and measuring methods as well as a detailed presentation of the results gained for each single converter. Because of the very different stages of development of the investigated machines it was impossible to operate all of them at the same time and to carry out the original planned comparative investigations. (orig.). With 61 figs., 19 tabs.

31774 **A computer analysis of wind turbine blade dynamic loads.** Thresher, R.W.; Wright, A.D.; Hershberg, E.L. (Solar Energy Research Institute, Wind Energy Research Center, Golden, CO 80401). *Journal of Solar Energy Engineering;* **108**: No. 1, vp(Feb 1986).

The flapping motion of a single wind turbine rotor blade has been analyzed and equations describing the flapping motion have been developed. The analysis was constrained to allow only flapping motions for a cantilevered blade, and the equations of motion are linearized. A computer code, called FLAP (Force and Loads Analysis Program), to solve the equations of motion and compute the blade loads, has been completed and compared to measured loads for a 3-bladed downwind turbine with stiff blades. The results of the program are presented in tabulated form for equidistant points along the blade and equal azimuth angles around the rotor disk. The blade deflection, slope and velocity, flapwise shear and moment, edgewise shear and moment, blade tension, and blade torsion are given. The deterministic excitations considered in the analysis include wind shear, tower shadow, gravity, and a prescribed yaw motion.

20 ELECTRIC POWER ENGINEERING

2001 Power Plants And Power Generation

REFER ALSO TO CITATION(S) 31370, 31375, 31962, 31964, 31989, 32052, 32179

31775 (CRIEPI—284066) Development of gas turbine simulation program for coal gasification combined cycle evaluation. Yasuo, A. (Central Research Inst. of Electric Power Industry, Tokyo (Japan)). 1985. vp. Central Research Inst. of Electric Power Industry, Tokyo, Japan.

A simplified simulation of an air-cooled gas turbine for coal gasification combined-cycle use was developed, and the relation between efficiency and blade metal temperature, and between deposits and hot-corrosion for several types of air-cooled gas turbine examined. For air-cooled gas turbines, the gas turbine efficiency hardly increases further if the turbine inlet temperature rises above about 1300°C. If the fuel includes alkali metal, it is necessary to apply anti-hot corrosion, thermal barrier coatings to blades to suppress blade cooling and to maintain efficiency.

31776 (DOE/MC/21284—2008) Gas turbine component screening program: fuel flexible combustor. LeCren, R.T. (Solar Turbines, Inc., San Diego, CA (USA)). Jan 1986. Contract AC21-84MC21284. 31p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86001080.

An advanced two stage coal-water mixture, high-pressure gas turbine combustion system has been designed and built. The combustor is a 1/10 scale in volume of that required for the Solar Model H Centaur gas turbine engine. It features a rich primary zone, lean secondary zone with hot refractory walls in both zones. Molten slag removal is accomplished inertially using a form of jet impaction. The primary and secondary air flows are supplied separately which allows precise control and measurement of zonal equivalence ratios and flow splits. A description of each component of the combustion system is presented along with a discussion of the suggested theory of operation. The test setup and instrumentation are also described. 13 figs., 4 tabs.

31777 (CE-Trans—8146) Effects of earthquakes on power station components. Hintergraber, M.; Wittmann, R. Translated from *VGB Kraftwerkstechnik ;* **64**: No. 1, 13-17(Jan 1984). 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901278.

This report discusses the question as to how far the computer methods currently used are suitable for describing the actual behavior to be expected from power station components under seismic loads. (JDB)

31778 Conversion-to-coal rules issued by the DOE (US Department of Energy). *Pipeline and Gas Journal;* **206**: No. 1, 2(Jan 1979).

Economic Regulatory Administration (ERA) prohibits new industrial facilities from using oil or gas as a primary energy source unless ERA grants a specific exemption. According to the rules required by the new Power Plant and Industrial Fuel Use Act, a user can be exempted if the cost of using coal is prohibitive, if pollution regulations preclude the use of coal, or if conversion would increase the user's capital budget by more than 25%. ERA plans to redefine natural gas to include gas wells owned by utilities or industrial users that produce less than 250,000 cu ft/day, effectively prohibiting such users from burning gas from their own captive wells.

2002 Environmental Control Technology

REFER ALSO TO CITATION(S) 31314, 31345, 32178, 32730

31779 (EPRI-CS—4386) Selective catalytic reduction for coal-fired power plants: pilot plant results. Final report. Shiomoto, G.H.; Muzio, L.J. (KVB, Inc., Irvine, CA (USA)). Apr 1986. 377p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920270.

Ammonia-based selective catalytic reduction (SCR) has been proposed as a means of reducing NO/sub x/ emissions from coal-fired utility boilers well below current federal standards. EPRI is conducting a technical evaluation of the SCR process on a 5000 scfm pilot-scale facility at the EPRI Arapahoe Test Facility. The pilot-scale system treats a 5000 scfm slipstream of flue gas (2.5 MWe equivalent) from Arapahoe Unit 4 which fires a western low sulfur coal. In addition to the SCR reactor, the system includes a regenerative air heater to assess impacts on air heater performance. The results obtained during a one-year test program are presented. These include (1) the process performance (NO/sub x/ removal), (2) impacts of secondary emissions, including ammonia, SO_3, and ammonium/sulfate compounds, (3) impacts of increased SO_2 levels, (4) impacts on the air preheater due to deposit buildup, and (5) evaluation of the SCR process requirements, including the ammonia injection controls, and the performance and maintenance of flue gas monitoring systems. 50 figs., 15 tabs.

31780 (EPRI-CS—4404-Vol.1, pp 9.1-9.13) High temperature gas filtration with ceramic filter media: problems and solutions. Chang, R. (Acurex Corp., Mountain View, CA). Feb 1985. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920156. (CONF-840859—Vol.1). Contract AC21-83MC20110;AC21-80ET17092.

From 5. symposium on the transfer and utilization of particulate control technology; Kansas City, MO, USA (27 Aug 1984).

Filter media suitable for use at temperatures greater than 550°F, employing ceramic fibers in their construction, have been under development for several years. These filter media are intended for application in advanced energy processes such as pressurized, fluidized bed combustion and gasification as well as any diverse industrial processes with temperatures ranging from 600° to 1600°F. The severe environment existing in these processes and the fragile nature of ceramic media pose a unique set of problems requiring special solutions. Ceramic media development work to date has shown significant progress toward achievement of a commercially viable high-temperature filter. This paper summarizes the results of various hot gas cleanup applications using different ceramic filters, the problems encountered, and the solutions achieved. 5 references, 3 figures, 2 tables.

31781 (EPRI-CS—4404-Vol.4, pp 16.1-16.9) Update of dry-sodium injection in fabric filters. Hooper, R.; Carr, R.C.; Bland, V.; Muzio, L.J.; Green, G.P.; Keeth, R. (Electric Power Research Institute, Palo Alto, CA). Feb 1986. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920159. (CONF-840859—Vol.4).

From 5. symposium on the transfer and utilization of particulate control technology; Kansas City, MO, USA (27 Aug 1984).

Injection of dry-sodium powders into the inlet plenum of fabric filters (baghouses) has been demonstrated to be an effective flue gas desulfurization (FGD) technique. On a full-scale utility boiler, injected sodium products have been shown to meet New Source Performance Standards (NSPS) of 70% removal for low-sulfur coal applications. Higher levels of SO_2 removal have also been demonstrated with the injection of greater quantities of sodium reagent. The low capital cost and simplicity of the dry-injection process make it particularly applicable in retrofit applications. Supply of sodium reagents is becoming increasingly more abundant as several chemical commodity suppliers expend both re-

search and venture capital dollars to enter the potential utility market. To data, sodium bicarbonate reagents have been shown to provide better sodium utilization than sodium sesquicarbonate reagents. Recent economic estimates confirm a much lower capital cost required for the dry-injection technology when compared to lime spray drying. The levelized cost of dry-injection is sensitive to reagent cost and utilization. Tests are proceeding at the Electric Power Research Institute's Arapahoe Test Facility to evaluate injection procedures and several upgraded reagents. 4 references, 6 figures.

31782 **(PB—86-156247/XAB) Analysis of costs and cost effectiveness of SO_2 control for mixed-fuel-fired steam generating units. Final report.** (Radian Corp., Research Triangle Park, NC (USA)). Jan 1986. 69p. NTIS, PC A04/MF A01.

The document presents an analysis of the costs and cost effectiveness of SO_2 control for steam-generating units firing mixtures of sulfur-bearing fossil fuels (coal or oil) with nonsulfur-bearing fuels (wood, solid waste, natural gas, etc.). The incremental cost effectiveness of an alternative control level requiring a percent reduction in SO_2 emissions over an alternative control level based on the use of low sulfur fuel was examined for various boiler sizes, regional locations, and fuel mixtures. The incremental cost effectiveness increases as decreasing amounts of coal or oil are burned in relation to nonsulfur-bearing fuels. The report also examines the costs associated with allowing versus not allowing emission credits based on the dilution of the sulfur-bearing fuel heat input with that from nonsulfur-bearing fuels.

31783 **(PB—86-156452/XAB) Computer economics of physical coal cleaning and flue gas desulfurization. Final report. Report for October 1979-June 1983.** Wright, C.R.; Larkin, L.; Kennedy, F.M.; Tarkington, T.W. (Tennessee Valley Authority, Muscle Shoals, AL (USA). Div. of Energy Demonstrations and Technology). Sep 1985. 173p. NTIS, PC A08/MF A01.

The report describes a computer model developed by TVA to simulate the performance and determine the economics of coal cleaning, or coal cleaning combined with flue gas desulfurization (FGD), for power plant emission control processes over a wide range of user-specified conditions. The model also calculates the other economic benefits and penalties to overall power plant operation that result from the use of cleaned coal. The report describes: (1) the programs composing the model, (2) the design and economic premises on which the calculations performed by the model are based, (3) the designs for the coal-cleaning and the FGD processes, and (4) the economic benefits and penalties associated with the use of cleaned coal by a power plant. A variety of cases were simulated, and selected results from these runs are described.

31784 **(PB—86-156536/XAB) EPA's LIMB (Environmental Protection Agency's Limestone Injection Multistage Burner) research, development, and demonstration program. Report for September 1984-January 1986.** Hendriks, R.V.; Nolan, P.S. (Environmental Protection Agency, Research Triangle Park, NC (USA). Air and Energy Engineering Research Lab.). Feb 1986. 18p. NTIS, PC A02/MF A01.

The paper describes and discusses key design features of the retrofit of EPA's Limestone Injection Multistage Burner (LIMB) system to an operating, wallfired utility boiler at Ohio Edison's Edgewater Station, based on the preliminary engineering design. It further describes results of pertinent projects in EPA's LIMB program and shows how these results were used as the basis for the design of the system. The full-scale demonstration is expected to prove the effectiveness and cost of the LIMB concept for use on large-scale utility boilers. To date, a preliminary engineering design for the Edgewater unit has been prepared incorporating the technology developed in smaller-scale studies. The schedule calls for system start-up by March 1987. EPA is engaged in a multi-year program to develop an improved control technology for emission of sulfur and nitrogen oxides (SOx and NOx) from the combustion of fossil fuels. The technology, called LIMB, involves staged-flow coal burners and injection of a reactive sorbent into the furnace to reduce emissions. The program includes fundamental studies of reaction chemistry and kinetics, bench- and pilot-scale experimental studies, a full-scale demonstration, and economic and applicability studies. It is structured to establish a basis for future public-sector commercialization, as well as help understand the technology's controlling factors.

31785 **(PB—86-158854/XAB) Fate of mercury released from power plants. Final report.** Zoller, W.H.; Barley, G.K.; Germani, M.S.; Ballantine, D.S. (Maryland Univ., College Park (USA). Dept. of Chemistry). Apr 1983. 82p. NTIS, PC A05/MF A01.

The goals of the project were to measure the quantity and form of mercury emitted from power plants in Maryland, estimate plume concentrations, and study the mercury in the plume. In addition, measurements of organic mercury in the vicinity of a power plant were to be conducted to investigate the potential mobilization of mercury released from the plants into the biosphere. The results of the measurements on fossil fuels showed that the average concentration of mercury in coal and oil burned in the state is 0.47 ppm and 20 ppb, respectively. The release of mercury from oil combustion in power plants is insignificant as compared to that released by coal combustion. The annual emission rates of mercury are approximately 3 tonnes for power plants, as compared with 1 ton from municipal incinerators, the next largest source in the metropolitan region. The results of the in-stack samples show that 98% of the mercury was in the gas phase which is in agreement with the studies done elsewhere.

31786 **A field study of a combined NH_3-SO_3 conditioning system on a cold-side fly ash precipitator at a coal-fired power plant.** Dahlin, R.S.; Marchant, G.H. Jr.; Gooch, J.P.; Bickelhaupt, R.E.; Sears, D.R.; Altman, R.F. (Southern Res. Inst., Birmingham, AL). *Proceedings, Annual Meeting, Air Pollution Control Association;* **5**: 16(1984). (CONF-840612—). Contract AC18-80FC10225.

From Air Pollution Control Association annual meeting; San Francisco, CA, USA (25 Jun 1984).

This paper describes the results of a field study of a combined NH_3-SO_3 conditioning system used to improve the performance of a cold-side electrostatic precipitator at a large coal-fired power plant. The combined NH_3-SO_3 conditioning system was placed into continuous service after numerous tests by plant personnel showed that the combined NH_3-SO_3 system was more effective than the use of either nh_3 or SO_3 alone. In the tests by plant personnel, the effectiveness of various injection locations and injection rates of one or both agents was judged on the ability to maintain an acceptable stack opacity. Based on the results of these tests, the plant management selected a combined conditioning system in which NH_3 is injected between the air heater and the precipitator at a rate of 5 ppM, and SO_3 is injected ahead of the air heater at a rate of 9 ppM. This was in addition to 5 ppm of SO_3 that is produced naturally in the pulverized coal-fired boiler. In most applications of flue gas conditioning, the SO_3 is injected downstream of the air heater; however, it is believed that injection ahead of the air heater, as was done at this plant, may result in a more uniform distribution of the SO_3 in the flue gas and more effective utilization of the SO_3.

2003 Power Transmission And Distribution

31787 (CONF-850241—, pp 99-103) **Microcomputer control and monitoring of heat transfer experiments with underground power cables.** Bernath, A.; Olfe, D.B. (Univ. of California, San Diego, La Jolla). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A microcomputer and data acquisition system is used to monitor and control heat transfer experiments at an underground power cable test site. The site has large distribution power cables in a duct bank with a large number of thermocouple temperature sensors in the cables and surrounding media. Experiments consist of specifying a given cable load cycle for cyclic or transient conditions and measuring the increased temperatures produced by cable heat losses. Temperature data for a number of experimental cases

has been used to determine the accuracy of existing theoretical models.

31788 (CONF-850241—, pp 327-335) **Microcomputer program for calculating temperatures of underground power cables.** Olfe, D.B.; Bernath, A. (Univ. of California, San Diego, La Jolla). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Power cable heat transfer calculations have been programmed in BASIC for the IBM Personal Computer. Using this program, utility engineers can predict cable temperatures for given loads, or calculate maximum currents (ampacities) for given cable temperature constraints. The program is similar to Fortran programs being used on mainframe computers. However, this microcomputer program has a more convenient and faster format for the input of data, provides graphical displays of the cable configurations, and enables instant portability since the program can be used on a standard IBM PC. Because the program is written in BASIC, it can be rapidly modified and customized by the user. The program can be directly compiled by the IBM BASIC compiler to provide fast running times.

31789 **(TTKK-SVT—1983/3) Interactive computer programs for public electricity network design.** Lakervi, E. (Tampere Univ. of Technology (Finland). Electrical Power Engineering). Mar 1983. 27p. (In Finnish). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751072.

This is a temporary report of a research project led by the author. During four recent years computer programs have already been accomplished for network design purposes. They are developed for a VAX 11/780 computer with a digitising table and graphic terminals. Nearly twenty commercial studies have been made for Finnish power industry as research contracts. The final reports of this project will be published during the year 1984 for the development of algorithms and studies concerning load curve analysis and reliability are still unfinished.

31790 **(TTKK-SVT—1983/4) Comparison of electricity distribution network schemes for housing estates.** Lakervi, E. (Tampere Univ. of Technology (Finland). Electrical Power Engineering). Mar 1983. 18p. (In Finnish). Tampere Univ. of Technology (Finland). Electrical Power Engineering.

The street network of a housing estate is assumed to be formed from squares. The low voltage network covers all streets and has a constant distribution of loads. Various simple symmetric distribution network schemes have been developed for these kind of town plans. Cost comparison studies have proved that the scheme to be selected is influenced by the distance between parallel streets in the area. The network schemes and results of comparative computer calculations are represented. Selecting a too simple scheme for a densely populated area leads to high extra network costs. The study is based only on costs of construction and losses. Therefore the results should be applied very carefully to practical design purposes.

31791 **Protection problems related to distribution systems with interconnected dispersed-storage-generation devices.** Rizy, D.T.; Dugan, R.C. (Oak Ridge National Lab., Energy Div., McGraw-Edison Co., Power Sys. Div.). pp 137-141 of Eighth international conference on electricity distribution. London, England; Institution of Electrical Engineers (1985). (CONF-850502—).

From 8. international conference on electricity distribution; Brighton, UK (20 May 1985).

A dispersed storage and generation (DSG) device connected to an electric utility distribution system can cause operating problems for both the DSG device owner and the utility. The effect of a DSG device on distribution system operations and the effect of distribution system operations on a DSG device were studied to determine the most practicable, cost-effective solutions to problems encountered by DSG owners and utilities.

21 NUCLEAR POWER PLANTS

2101 Power Reactors, Non-breeding, Light-water Moderated, Boiling Water Cooled

REFER ALSO TO CITATION(S) 31612, 31809, 31898, 31911, 31913, 31923, 31939, 31946, 31947, 31948, 31950, 31951, 31952, 31955, 31956

31792 **(BARC—1258) Nuclear design report on Tarapur 7 x 7 reload-3 fuel.** Jagannathan, V.; Mohanakrishnan, P.; Srinivasan, K.R.; Kumar, V.; Srivenkatesan, R.; Balaraman, V.; Vaidya, S.G.; Rastogi, B.P. (Bhabha Atomic Research Centre, Bombay (India)). 1985. 38p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702052.

The physics design of the proposed 7 x 7 fuel assembly has been carried out with the latest version of the BWR fuel box lattice cell code SUPERB. This report gives the nuclear design characteristics of the 7 x 7 fuel assembly. The corresponding nuclear parameters of the existing 6 x 6 reload-2 fuel assembly are also included in this report for ready reference and intercomparison. The nuclear data presented here include: (i) the information needed for steady state operation with the 7 x 7 fuel and (ii) kinetic parameters and reactivity coefficients which are required for safety analyses. Preliminary core design calculations of the mixed core with one reload batch of 7 x 7 fuel (100 fresh 7 x 7 fuel assemblies) were performed with the BWR simulator code COMETG. These calculations demonstrate: (i) the shut down capability, (ii) compatibility of 7 x 7 fuel with the present 6 x 6 fuel, and (iii) cycle energy potential of 7 x 7 reload batch vis-a-vis 6 x 6 reload batch.

31793 **(DOE/ET/34006—19) Extended Burnup Demonstration Reactor Fuels program. Final project report.** Exarhos, C.A. (Consumers Power Co., Jackson, MI (USA); Exxon Nuclear Co., Inc., Richland, WA (USA); GPU Nuclear Corp., Parsippany, NJ (USA)). 7 Apr 1986. Contract AC02-79ET34006. 71p. (XN-NF—86-13). NTIS (US Sales Only), PC A04/MF A01; GPO Dep. File Number DE86009976.

The US Department of Energy, Consumers Power Company, Exxon Nuclear Company, and GPU Nuclear have participated since 1979 in a cooperative Extended Burnup Demonstration program. Under the program, standard ENC-fabricated reload fuel in the Big Rock Point and Oyster Creek cores was irradiated to discharge burnups in excess of 35,000 MWD/MTU, one to three cycles beyond its originally projectd exposure life. Post-irradiation examinations of the fuel were conducted at poolside before and after each extended burnup cycle. These were supplemented by poolside measurement of fission gas release and fuel gamma activity profiles and by destructive examination of four fuel rods in a hot cell. The program was completed in 1985 with the final discharge of fuel irradiated at Big Rock Point to a peak rod average exposure of 45,100 MWD/MTU. This report reviews the results obtained throughout the EBD program, and discusses the post-irradiation examination results in terms of their implications for high burnup fuel designs. The program was successful not only in demonstrating that ENC's standard BWR design could be irradiated to higher than warranted exposures but also in providing an extensive data base against which to evaluate future high burnup designs.

31794 **(DOE/ET/34215—39) Fuel Performance Improvement Program. Final report.** Patterson, J.F. (comp.). (Consumers Power Co., Jackson, MI (USA); Exxon Nuclear Co., Inc., Richland, WA (USA)). 28 Apr 1986. Contract AC02-76ET34215. 294p. (XN-NF—85-122). NTIS (US Sales Only), E08/MF $8.75; 1; GPO Dep. File Number DE86010422.

The Fuel Performance Improvement Program (FPIP) originated in 1977 as a prime contract between the US Department of Energy and Consumers Power Company. Exxon Nuclear Company and Battelle's Pacific Northwest Laboratories performed the major technical tasks under the overall guidance of Consumers Power. The FPIP covered the fabrication and irradiation testing of standard and advanced light water reactor fuel designs. In addition to standard LWR fuel, three advanced fuel concepts were experimen-

tally evaluated: (1) annular pellets, (2) cladding internally coated with a layer of graphite, and (3) particles of UO_2 in the form of either Vipac or Sphere-Pac fuel. Irradiation and testing were performed in the Halden Boiling Water Reactor in Norway, the Big Rock Point BWR in Michigan, USA, and the Studsvik R-2 test reactor in Sweden. This FPIP Final Report summarizes the overall results of the program through its completion in December 1985. More detailed information can be obtained from the extensive list of references included in this report.

31795 **(EPRI-NP—4514-SR-LD) Nuclear Systems and Materials Department research program plan: 1986.** Stahlkopf, K.E. (Electric Power Research Inst., Palo Alto, CA (USA). Nuclear Systems and Materials Dept.). Mar 1986. 225p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920261.

Plans are presented for research and development in the areas of component reliability, corrosion control, LWR fuel, the fuel storage component of radioactive waste management, and future LWRs. Fifty recent accomplishments are described which relate to: inspection and flaw detection, structural mechanics, TMI-2 information and examination, corrosion control, nuclear fuels, the external fuel cycle, and the advanced light water reactor program. The goals, objectives, and 1986 plans are given for each program element. All of the individual projects that are expected to be active during some part of 1986 are summarized. (LEW)

31796 **(EPRI-NP—4524) Oxidation of spent fuel at between 250 and 360°C.** Einziger, R.E. (Westinghouse Hanford Co., Richland, WA (USA)). Apr 1986. Contract AC06-76FF02170;W-31-109-ENG-38. 100p. NTIS, PC A05/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1; GPO Dep. File Number DE86010873.

Oxidation tests on spent fuel fragments and rod segments were conducted between 250°C and 360°C to relate temperature and defect size with fuel oxidation rate and time-to-cladding-splitting. Defect sizes from an equivalent circular diameter of 8 μm [the approximate size of a stress-corrosion-cracking (SSC) type breach] to 760 μm were used. Samples, held at temperature in a flowing air atmosphere, were frequently weighed and visually observed to determine the oxidation rate and effects of oxidation. Both the size and shape of the defect appear to influence the time-to-cladding-splitting. Above 283°C, time-to-cladding-splitting was longer for the sharp small defect than for the large circular defect, an effect that diminished as the temperature decreased. By 250°C the sharp small defects split open before the large circular defects, indicating that, at lower temperatures, the defect's shape and not its size may be more important when determining time-to-cladding-splitting. The time-to-spallation for bare fuel is a lower bound for the time-to-cladding-splitting. At both 283 and 295°C, the defects in fuel rod segments with lower burnups propagated sooner than those in rod segments with higher burnup from the same parent rod. A comparison of the behaviors of BWR and PWR breached rod segments was inconclusive. The cumulative damage fraction approach, using a reasonable decreasing time/temperature profile, was applied to determine time-to-cladding-splitting for PWR fuel with a burnup >640 MWh/kg (25.6 GWd/MT) of uranium. Breached PWR fuel rods will not split open from fuel oxidation during 100 years of storage if the rod is not exposed to air until the temperature drops below 230°C. Lower burnup fuel apparently requires lower temperature limits. The temperature limits are not very sensitive to oxidation rates but depend strongly on the time-dependent temperature profile in the storage container. 51 refs., 37 figs., 22 tabs.

31797 **(EPRI-NP—4560) Cobalt transport at the Vermont Yankee BWR.** Palino, G.F.; Hobart, R.L.; Wall, P.S.; Sawochka, S.G.; Gardner, J.; Prystupa, M. (NWT Corp., San Jose, CA (USA); Vermont Yankee Nuclear Power Corp., Brattleboro (USA)). May 1986. 117p. Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303. File Number TI86920262.

The behavior of Co-59 (the precursor of Co-60) is of particular interest in BWRs since Co-60 has been shown to be primarily responsible for BWR shutdown radiation levels. To assist in understanding cobalt transport in the BWR, a cobalt solution was injected at the effluent of the condensate demineralized system and was transported to the primary system via the feedwater at the Vermont Yankee BWR. The quantity injected was equivalent to the amount transported during routine operation over approximately 7 days. Sample system modified to eliminate cobalt bearing alloys were demonstrated to provide valid process stream samples for cobalt. Cobalt injected at the effluent of the condensate demineralizers was retained in portions of the feedwater cycle for approximately six hours prior to the initial indication of an increase in cobalt transport to the primary system. This anomaly, which led to considerable difficulty in interpreting concentration variations observed during and subsequent to the injection, is attributed to chemi-sorption of cobalt on iron oxide coated surfaces of the condensate/feedwater system. A similar phenomenon also occurred in the primary system thus eliminating the possibility of establishing an absolute value for the primary system cobalt source strength. Nonetheless, it was possible to infer that cobalt transported to the reactor by the feedwater was the primary source of cobalt available for deposition on the fuel. 14 figs., 13 tabs.

31798 (IAEA-TECDOC—356, pp 13-62) **Water chemistry of nuclear power reactors. Evaluation of specifications for water quality.** Dobrevsky, I.D. (Vissh Khimiko-Tekhnologicheski Inst., Burgas, Bulgaria). Nov 1985. NTIS (US Sales Only), PC A10/MF A01. File Number DE86702053.

In Fuel cladding interaction with water coolant in power reactors. A survey report of a coordinated research programme on the investigation of fuel element cladding interaction with water coolant in power reactors.

The need to ensure the integrity of fuel element cladding and equipment in the reactor, to increase their reliability and to minimize radiation dose rate in the out-of-core parts poses certain requirements towards cooling water quality. These specifications limit impurity concentration in reactor water and set the concentration range of additives to the reactor water. The specifications of coolant water quality are different for the different nuclear power reactors. These differences depend mainly on reactor type (PWR, BWR, PHWR, SGHWR, etc.) and on type and composition of construction materials for components. The following survey of water chemistry in the nuclear power stations is therefore divided into two main parts, viz.: PWR primary circuit water chemistry; BWR reactor water and feedback chemistry. The special features of the heavy water reactors are given under a separate heading.

31799 **(IAEA-TECDOC—356) Fuel cladding interaction with water coolant in power reactors. A survey report of a coordinated research programme on the investigation of fuel element cladding interaction with water coolant in power reactors.** (International Atomic Energy Agency, Vienna (Austria)). Nov 1985. 225p. NTIS (US Sales Only), PC A10/MF A01. File Number DE86702053.

Water coolant chemistry and corrosion processes are important factors in reliable operation of NPP's, as at elevated temperatures water is aggressive towards structural materials. Water regimes for commercial Pressurized Water Reactors and Boiling Water Reactors were developed and proved to be satisfactory. Nevertheless, studies of operation experience continue and an amount of new Research and Development work is being conducted for further improvements of technology and better understanding of the physicochemical nature of those processes. In this report information is presented on the IAEA programme on fuel element cladding interaction with water coolant. Some results of this survey and recommendations made by the group of consultants who participated in this work are given as well as recommendations for continuation of this study. Separate abstracts were prepared for 6 papers of this report.

31800 (IAEA-TECDOC—356, pp 7-9) **Role of water chemistry in reliable operation of nuclear power plants.** Rybalchenko, I. (International Atomic Energy Agency, Vienna, Austria. Div. of Nuclear Fuel Cycle). Nov 1985. NTIS (US Sales Only), PC A10/MF A01. File Number DE86702053.

In Fuel cladding interaction with water coolant in power reactors. A survey report of a coordinated research programme on the investigation of fuel element cladding interaction with water coolant in power reactors.

In the present and for the near future, nuclear power development in the world is based mainly upon water-cooled reactors. It means that reliability of many systems at nuclear power plants depends much upon water control there. It is especially important for primary circuits and fuel cladding. The main problems related to water chemistry are briefly discussed in the introduction to this survey report of a co-ordinated research programme on the investigation of fuel element cladding interaction with water coolant in power reactors.

31801 (IAEA-TECDOC—356, pp 65-118) **Deposition and migration of corrosion products and impurities.** Ferrett, D.J.; Comley, G.C.W. Nov 1985. NTIS (US Sales Only), PC A10/MF A01. File Number DE86702053.

In Fuel cladding interaction with water coolant in power reactors. A survey report of a coordinated research programme on the investigation of fuel element cladding interaction with water coolant in power reactors.

Experience gained over a quarter of a century with the operation of all types of water-cooled nuclear reactor systems has highlighted a common radioactivation problem. This results from the transport of activated corrosion products in coolant circuits which were originally released from the constructional materials of the power plant itself. The occupational dose question that follows from this phenomenon is not the concern of this review but it is the motivating factor behind continuing intensive programmes of worldwide research. These programmes have focused on the question of corrosion product release, active nuclide formation and transport processes in water-cooled reactor circuits.

31802 (IAEA-TECDOC—356, pp 121-185) **Corrosion and hydriding of fuel cladding materials.** Gadiyar, H.S. (Bhabha Atomic Research Centre, Bombay, India. Metallurgy Div.). Nov 1985. NTIS (US Sales Only), PC A10/MF A01. File Number DE86702053.

In Fuel cladding interaction with water coolant in power reactors. A survey report of a coordinated research programme on the investigation of fuel element cladding interaction with water coolant in power reactors.

The corrosion behaviour of zirconium alloys in the coolant water has been discussed from the point of view of oxide growth and hydrogen absorption in the context of their use for fuel cladding and pressure tube materials. History on the development of alloys has shown work on two types of alloys. In the first, studies based on the zirconium-tin system have led to the emergence of two potential alloys Zircaloy-2 and -4. In the other, extensive investigations on zirconium-niobium alloys have given rise again to two major alloys, namely, Zr-1Nb and Zr-2.5Nb. The major efforts regarding corrosion studies were on the parameter studies which included coolant chemistry, flux level, alloy composition and metallurgical condition.

31803 (NUREG—0020-Vol.10-No.2) **Licensed operating reactors. Status summary report data as of January 31, 1986. Volume 10, No. 2.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Resource Management). Mar 1986. 442p. NTIS, PC A19/MF A01 - GPO. File Number TI86901169.

This report is divided into three sections: the first contains monthly highlights and statistics for commercial operating units, and errata from previously reported data; the second is a compilation of detailed information on each unit, provided by NRC Regional Offices, IE Headquarters and the Utilities; and the third section is an appendix for miscellaneous information such as spent fuel storage capability, reactor years of experience and non-power reactors in the United States.

31804 (NUREG/CR—4583-Vol.1) **Development and validation of a real-time SAFT-UT system for the inspection of light water reactor components. Semiannual report, April 1984-September 1984. Volume 1.** Doctor, S.R.; Busse, L.J.; Crawford, S.L.; Hall, T.E.; Gribble, R.P.; Baldwin, A.J.; Van Houten, L.P. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 91p. (PNL—5822-Vol.1). NTIS, PC A05/MF A01 - GPO. File Number TI86010604.

The Pacific Northwest Laboratory is working to design, fabricate, and evaluate a real-time flaw detection and characterization system based on the synthetic aperture focusing technique for ultrasonic testing (SAFT-UT). The system is for inservice inspection of light water reactor components. Included objectives of this program for the Nuclear Regulatory Commission are to develop procedures for system calibration and field operation, to validate the system through laboratory and field inspections, and to generate an engineering data base to support ASME Code acceptance of the technology. This process report covers the programmatic work from April 1984 through September 1984. 58 figs.

2102 Power Reactors, Non-breeding, Light-water Moderated, Non-boiling Water Cooled

REFER ALSO TO CITATION(S) 31794, 31795, 31796, 31798, 31799, 31800, 31801, 31802, 31803, 31804, 31887, 31888, 31889, 31890, 31895, 31897, 31898, 31899, 31900, 31903, 31904, 31905, 31908, 31909, 31910, 31911, 31912, 31913, 31923, 31939, 31946, 31947, 31948, 31949, 31950, 31952, 31953, 31954, 31955, 31956, 31958

31805 **(CNEN-DR—131/85) Study of the influence of the power distributions in the minimum DNBR for Angra 1 reactor.** Silva Galetti, M.R. da; Pontedeiro, A.C.; Camargo, C.T.M. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Dept. de Reatores). 1985. 49p. (In Portuguese). (CNEN-DR-GTT—01/85). NTIS (US Sales Only), PC A03/MF A01. File Number DE86702057.

The design basis of the Westinghouse DNB protection system has been investigated with respect to the influence of the power distributions in the OTΔT setpoint. All analysis were performed using the COBRAIIIP code for Angra 1 NPP reactor core.

31806 **(EPRI-NP—4521) Resin and ionics leakage from condensate polishers with and without inert resin. Final report.** Stauffer, C.C. (Babcock and Wilcox Co., Alliance, OH (USA). Research and Development Div.). Apr 1986. 78p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920260.

The secondary cycle at ANO-1 was studied before and after modification to incorporate inert resin in the mixed-bed polishers, to compare the systems on the basis of resin and contaminant leakage. Concentrations of two ionic species (sulfate and chloride) and suspended resin fragments were determined at various points in the secondary cycle. These concentrations were determined at steady state and as a function of time during transients. Resin fragment samples were obtained by passing water through membrane filters and analyzed using procedures developed in a previous EPRI study and reported in EPRI report NP-2981. Pre- and post-modification results were compared with data from similar plants. 13 tabs.

31807 **(EPRI-NP—4529) Effects of Zircaloy oxidation and steam dissociation on PWR core heat-up under conditions simulating uncovered fuel rods.** Viskanta, R.; Mohanty, A.K. (Purdue Univ., Lafayette, IN (USA). School of Mechanical Engineering). Apr 1986. 80p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920259.

The studies described in this report identify the regimes of slow transients in a partially uncovered core of a PWR. The threshold height and onset time for oxidation of the cladding of a fuel rod have been evaluated. The effects of oxidation in increasing the decay heat load, component temperature, reduction of cladding thickness and generation of hydrogen have been estimated. The condition for steam starvation has been determined. At high uncovered core heights, typically say 2.8 m for a geometry simulating the TMI-2 type of reactor, the solid and coolant temperatures can reach the limits of steam dissociation. The effects of radiation heat exchange between cladding and coolant, Zircaloy oxidation, steam dissociation, gap conductance between fuel and cladding and system pressure on the heatup of fuel rods have been investigated. The time for uncovering a certain core height is taken as the independent parameter. It is seen that if the uncovering process is allowed to continue beyond 9 minutes corresponding to an uncovered height of 1.9 m, onset of cladding oxidation can be a reality.

These values provide a guideline for the response time of the emergency core cooling systems. 10 refs., 22 figs.

31808 **(EPRI-NP—4530) Two-phase flow regimes and carry-over in a large-diameter model of a PWR hot leg. Final report.** Hashemi, A. (Science Applications International Corp., Los Altos, CA (USA)). Apr 1986. 104p. Research Reports Center P.O. Box 50490 Palo Alto, CA 94303. File Number TI86920257.

This report describes a series of tests investigating two-phase flow characterization and carryover in a transparent model of a Babcock and Wilson (B and W) Pressurized Water Reactor (PWR) hot leg geometry. This work was performed, inpart, to support the interpretation of results from the Once-Through Integral System (OTIS) and Multi-loop Integral Test (MIST) facilities. Test conditions were selected to cover a wide range of gas and liquid superficial velocities (0.01 m/s $< j/sub\ g/ <$ 2 m/s, $0 < j/sub\ l/ <$ 0.5 m/s) expected to occur in a prototypical reactor geometry during a small break loss of coolant accident (SBLOCA). Tests at high gas superficial velocities ($j/sub\ g/ >$ 2 m/s) were also performed for comparison with semi-analytical predictions. Tests were conducted in two different test rigs, one with 10.2-cm (4-inch) diameter pipe, and the other with 30.5-cm (12-inch) diameter pipe. Results include average void fraction, amount of water carryover through the U-bend, transient flow rates and pressure histories, and video movies of the two-phase flow phenomena. Results of the 10.2-cm (4-inch) pipe tests show generally good agreement with the Taitel and Dukler (1) flow regime map for vertical pipes. For the 30.5-cm pipe tests, slug flow was not observed. Instead, as the air flow rate was increased, the flow regime progressed from bubbly to churn-type flow with the presence of large bubbles (approximately 15-cm diameter). The results also indicate that flow regimes and collapsed liquid level are more strongly dependent on air superficial velocity than the water superficial velocity and that the amount of water carryover for a given air flow rate is a strong function of collapsed water level (void fraction). Furthermore, the results show that similar thresholds for breakdown in natural circulation flow exist between the 10.2-cm and 30.5-cm pipe tests for gas and liquid superficial velocities expected in a SBLOCA. 20 refs., 24 figs.

31809 **(EPRI-NP—4561) Fuel and pool component performance in storage pools.** Bailey, W.J. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 88p. NTIS (US Sales Only), PC A05/MF A01; 1 - Research Reports Center, Box 50490, Palo Alto, CA 94303; GPO Dep. File Number DE86010593.

Battelle, Pacific Northwest Laboratories is continuing a surveillance program established in 1983 for EPRI that investigates the integrity of spent light-water reactor (LWR) fuel and structural materials such as spent fuel storage pool liners, piping, racks, etc. during wet storage (i.e., in water-filled spent fuel storage pools). Results of the work during 1983-1984 were published in EPRI NP-3765. The activities in 1984-1985 involved two tasks. The results from Task 1, "Surveillance of Spent Fuel Integrity During Wet Storage and General Performance of Spent Fuel Storage Pools," are described in this report. The results from Task 2, "Behavior of High-Density Spent Fuel Storage Racks," concerning use of and experience with neutron absorbing materials in racks are contained in another report. Characteristics of the domestic spent fuel inventories are provided. Relevant occurrences noted in recent Licensee Event Reports and other studies are summarized. EPRI's lead fuel assembly concept for validating safe wet storage for bounding storage conditions is described and a list of the associated lead fuel assemblies is presented. Experience to date continues to indicate that wet storage is a well-developed technology with no associated major technological problems. Spent fuel storage pools continue to be operated without substantial risk to the public or the plant personnel. Surveillance continues to be needed on: (1) possible effects on handling and storage of spent fuel from extended burnup, hydrogen injection at boiling water reactors, and rod consolidation operations; (2) behavior of inflatable pool seals; (3) control of metallic debris and impurities in spent fuel pool waters; (4) crud loosening on spent fuel after extended storage; (5) cracking of spent fuel storage pool piping at pressurized water reactors; and (6) extended pool exposure of neutron-absorbing materials in spent fuel storage racks. 90 refs.

31810 **(INIS-BR—466) Analysis of some anticipated transients without scram for a pressurized water cooled reactor (PWR) using coupling of the containment code CORAN to the system model code ALMOD.** Carvalho, F.deA.T. de. (Pernambuco Univ., Recife (Brazil). Dept. de Energia Nuclear). 1985. 98p. (In Portuguese). NTIS (US Sales Only), PC A05/MF A01. File Number DE86702063.

Some anticipated transients without scram (ATWS) for a pressurized water cooled reactor, model KWU 1300 MWe, are studied using coupling of the containment code CORAN to the system model code ALMOD, under severe random conditions. This coupling has the objective of including containment model as part of a unified code system. These severe conditions include failure of reactor scram, following a station black-out and emergency power initiation for the burn-up status at the beginning and end of the cycle. Furthermore, for the burn-up status at the end of the cycle a failure in the closure of the pressurizer relief valve was also investigated. For the beginning of the cycle, the containment participates actively during the transient. It is noted that the effect of the burn-up in the fuel is to reduce the seriousness of these transients. On the other hand, the failure in the closure of the pressurized relief valve makes this transient more severe. Moreover, the containment safety or radiological public safety is not affected in any of the cases.

31811 **(INIS-BR—468) Angra-1: Balance of an experience.** Salvo Brito, S. de. (FURNAS, Rio de Janeiro (Brazil)). 1985. 16p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702085.

Presented in the Latin American Section of the American Nuclear Society, vol.6, n.2, 1985.

An evaluation of experience gained during the construction of Angra-1 nuclear power plant which had built by FURNAS CENTRAIS ELETRICAS S.A. is done. Analyzed are the problems in level of management, including technology transfer. A balance of the real costs and benefits from the definition of the specifications to energy generation is done.

31812 **(INIS-BR—469) NUCLEBRAS' experience in the implementation of a nuclear power plants simulator.** Spitalnik, J.; Fonseca, G. (NUCLEBRAS, Rio de Janeiro (Brazil)). 1985. 10p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702064.

Presented in the Latin American Section of the American Nuclear Society, Vol.6, No.2, 1985.

The experiences gained by NUCLEBRAS in the setting up of a Nuclear Power Plant Simulator Training Center, cover the design and manufacture of the simulator for the Angra-2 type nuclear power plants, the training of the simulator operation and maintenance personnel, in preparation for the training of the Brazilian nuclear power plant operators, the development of the simulator training programs and materials, the temporary installation and utilization of the simulator in the FRG, including the training of operators of the Trillo nuclear power plant, in Spain. The simulator shall be finally installed in Brazil, at the vicinity of the Angra-2 site, in 1985, when it is foreseen to start the training of the Angra-2 operators.

31813 **(INIS-mf—10109) Economics, operating reliability and safety of WWER-440 type nuclear power plants. Part I. Preprints of papers.** (Atomova Elektraren Bohunice, Jaslovske Bohunice (Czechoslovakia)). 1984. 240p. (In Slovak and Czech). (CONF-8411248—Pt.1). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065.

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The first part of the collection of preprints contains papers presented at the conference organized by the Czechoslovak Scientific and Technical Society. Most papers deal with the V-1 nuclear power plant. The papers deal with increasing the efficiency of operation of the nuclear power plant, the statistical evaluation of failures and repairs of the most important components of the power plant, and with climatic effects on the performance WWER-440 reactors. The probability is compared of failures of the most impor-

tant equipment of nuclear power plants with WWER reactors and of selected foreign nuclear power plants.

31814 (INIS-mf—10109, pp 1-9) **Results and prospects of operation of Bohunice Atomic Power Plants.** Kozak, M. (Atomova Elektraren Bohunice, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The operation is evaluated of the V-1 nuclear power plant at Jaslovske Bohunice in the years 1979 to 1983. Project parameters are presented of the unit as are the results of unit operation. As concerns most parameters, the results achieved are better than expected by the project and 80% of the designed output is available. Waste heat from the power plant will be used for heating Trnava and in the future also other towns.

31815 (INIS-mf—10109, pp 3/1-3/10) **Results and experience with V-1 nuclear power plant operation.** Hodul, J. (Atomova Elektraren Bohunice, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The operational stabilization is described of the primary and secondary circuits, electrical equipment, the measurement and control system and chemical regime of the primary and secondary circuits of the V-1 nuclear power plant. The most frequent failures and faults are given for each equipment. Also evaluated is the influence of personnel on the stabilization and economy of operation of the nuclear power plant.

31816 (INIS-mf—10109, pp 7/1-7/12) **Application of microcomputers in V-1 nuclear power plant operation.** Martancik, J.; Gese, A.; Suchy, R. (Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

Computer-aided data acquisition at the V-1 nuclear power plant is described. Initially used Soviet computer systems IV 500 MA are gradually being replaced by RPP-16S computers. A program model of primary processing of data on the technological process of the unit and a program module for display and protocol print-out are described. An innovation is being prepared of nuclear power plant information computer systems using SMEP minicomputers and introducing minielectronics for increasing operating safety.

31817 (INIS-mf—10109, pp 9/1-9/10) **Fire fighting precautions at Bohunice Atomic Power Plants.** 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

Some shortcomings are discussed of the project design of fire protection at the V-1 and V-2 nuclear power plants. The basic shortcoming of the system is insufficient division of the units for fire protection. Fire fighting measures are described for cable areas, switch houses and outside transformers, primary and secondary circuits and auxiliary units. Measures are presented for increasing fire safety in Jaslovske Bohunice proceeding from experience gained with a fire which had occurred at a nuclear power plant in Armenia.

31818 (INIS-mf—10109, pp 10/1-10/12) **Probability assessment of cable fire risks in nuclear power plants.** Skvarka, P. (Vyskumny Ustav Palivoenergetickeho Komplexu, Pobocka Bratislava, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The economic risk is described of a fire breaking out in the cable area below the unit control room at the V-1 nuclear power plant. The causes are given of fires breaking out cable areas. The fire fighting system is divided into four subsystems. The flow chart is shown which serves to design the tree of events. Input data are given for the computation of economic damage.

31819 (INIS-mf—10109, pp 15/1-15/3) **Preparing nuclear power plant units for operation.** Hudcovic, R.; Telgarsky, K.; Kmosena, J. (Atomova Elektraren Bohunice, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The factors are listed which have to be taken into consideration for planning the unit operation, i.e., the implementation of planned repairs, checks of equipment and refuellings. All basis input data were evaluated as the basis for drawing up the schedule of routine repairs and overhauls for the coming period.

31820 (INIS-mf—10109, pp 17/1-17/12) **Increasing operating efficiency and reducing power and heat consumption of V-1 nuclear power plant.** Hatas, J.; Liska, P.; Benc, L. (Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The technical and economic parameters are evaluated of the V-1 nuclear power plant. The heat output of the reactor and the specific heat consumption for power production were measured. The results of the measurement are tabulated. Also monitored was power consumption of the V-1 nuclear power plant. The possibilities are discussed of increasing the operation efficiency of the power plant.

31821 (INIS-mf—10109, pp 18/1-18/7) **Statistical evaluation of failures and repairs of the V-1 measuring and control system.** Laurinec, R.; Korec, J.; Mitosinka, J.; Zarnovican, V. 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

A failure record card system was introduced for evaluating the reliability of the measurement and control equipment of the V-1 nuclear power plant. The SPU-800 microcomputer system is used for recording data on magnetic tape and their transmission to the central data processing department. The data are used for evaluating the reliability of components and circuits and a selection is made of the most failure-prone components, and the causes of failures are evaluated as are failure identification, repair and causes of outages. The system provides monthly, annual and total assessment data since the system was commissioned. The results of the statistical evaluation of failures are used for planning preventive maintenance and for determining optimal repair intervals.

31822 (INIS-mf—10109, pp 19/1-19/9) **Effect of climatic conditions on possible increase in output of WWER-440 nuclear power plant unit.** Sopira, V. (Vyskumny Ustav Palivoenergetickeho Komplexu, Pobocka Bratislava, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

A verification computation was made for condenser cooling in possible power upgrading above nominal output. The KOND program was used for the computation. Iteration computation was used for assigning pressure and temperature of condensing vapour in the two condensers to the pre-set temperature of air in the region of 5 to 40 deg C and air humidity in the region of 30 to 100%. Cooling curves of the V-1 nuclear power plant for basic temperature of cooled water of 24.5 deg C were used for the computation. The input parameters of the computation were taken from the heat diagrams of the nuclear power plant for power regimes of 100, 105, 110 and 115%. The computation was made for two variants: for the designed flow rate of cooling water and for higher values of flow rates of actual V-1 power plant operation. The results are tabulated. It was found that the critical pressure of 12 kPa in the condenser is not reached at characteristic temperatures. An evaluation is made of weather conditions during which criticai pressure is reached in the condensers and when power has to be out cut.

31823 (INIS-mf—10109, pp 20/1-20/19) **Safety limits of increasing output of WWER-440 units.** Pernica, R. (Ustav Jaderneho Vyzkumu CSKAE, Rez, Czechoslovakia). 1984. (In Czech). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The problems are discussed of limiting the nominal output of a nuclear power plant with WWER reactors owing to a simple failure of the main circulation pumps. The nominal output is limited mainly by the requirement that natural circulation should discharge the residual power of a shutdown reactor following the loss of forced circulation. The time course is discussed of the residual power of the reactor which is affected by its previous operation, and the principles are mathematically expressed of the permissible power of the previous regime, and of protective time. The limitation is discussed of the nominal output of the V-1 and V-2 nuclear power plants, resulting from the application of both principles. The limitation of the nominal output of the V-1 plant with WWER 440 reactors of the 230 type is mainly caused by low values of natural circulation, which were measured for six and four open circulation loops. In the nuclear power plant with WWER 440 reactors of the 213 type the circulation pumps have greater inertia which is the reason for a slower drop of forced coolant circulation following their outage. Some measurements needed for the evaluation have not yet been made. It may, however, be assumed that the possible outage of the main circulation pump will not be the reason for limiting the possible increase in the nominal output of the V-2 plant.

31824 (INIS-mf—10109, pp 22/1-22/5) **Operating reliability of V-1 nuclear power plant components.** Kmosena, J.; Ondrejka, S. (Atomova Elektraren Bohunice, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

Operating defects, operating failures, radiation accidents, ecological accidents, fires and violations of the principles of nuclear safety are monitored under enterprise regulations. A list is given of specifically monitored components. Tabulated are losses in production owing to failures of V-1 nuclear power plant components, this from 1979 to July 1984. The table shows that initially the most failure-prone components were high pressure heaters, the 220 kV switch house and the couplings of the main circulation pumps. They now include the vanes of high pressure turbogenerator rotors and steam generator collectors.

31825 (INIS-mf—10109, pp 23/1-23/14) **Application of information on WWER-440 nuclear power plant operation in monitoring reliability.** Dubrovcak, P. (Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

Tabulated are relations between certain properties, quantities and reliability indicators, the classification of components, their classification according to the time mode of operation, and the distribution of failure consequences and the limitation of the duration of the use of nuclear power plant components. In order to evaluate the reliability of the nuclear power plant, data are monitored relating to failures, defects and production, the operating loads of components of the primary and secondary circuits, and data on materials characteristics. The current state is discussed of computerized data collection, and the SIS data collection system is designed.

31826 (INIS-mf—10109, pp 24/1-24/6) **Probability analysis used to assess the reliability of electrical systems of WWER type nuclear power plants.** Kubanyi, J. (Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The system is evaluated of assured power supply of 1st category appliances (SYZAN-I) using event tree analysis. 66 failures and faults were selected for SYZAN-I components. Tabulated are the 5 most probable events for 720 hours and 2880 hours of operation. Graphically represented is the event tree for a motor generator.

31827 (INIS-mf—10109, pp 25/1-25/35) **Trends of failures of major components during V-1 nuclear power plant operation in the years 1980-1983 and comparison with foreign nuclear power plants.** Suchomel, J.; Maron, V. (Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

Operating characteristics are compared of the V-1 nuclear power plant and US nuclear power plants with PWR reactors. The categorization of failures of the V-1 plant in the years 1980 to 1983 is evaluated by the system used in the USSR and by the NSIC used in the USA. The differences are discussed in the failure rates of various nuclear power plant components. Failures of the V-1 nuclear power plant and of nuclear power plants in the USA are compared according to the causes, occurrence, component, instrumentation and type of plant. All data are tabulated. The main types of failures of the V-1 plant components are discussed, i.e., failures of turbogenerators, main unit controllers, electrical engineering equipment, systems of reactor protection and control, systems of feed water for steam generators, component leaks, incorrect adjustments of testing circuits, of protection and control circuits, deterioration of the chemical regime of the secondary circuit, multiple failures, failures due to the human factor and other failures.

31828 **(IPEN-Pub—73) Evaluation of XSDRN code for PWR cross-section generation.** Fanaro, L.C.C.B. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 15p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702103.

Evaluation of XSDRN code for the 4% enriched uranium oxide fueled Light-Water-Reactor cross-section generation was performed. The comparison were made against the HAMMER code results.

31829 (IPEN-Pub—85) Study of reliability of HAMMER-TECHNION code to calculate control rod worth in PWR's. Kosaka, N. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 15p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702104.

The HAMMER-TECHNION code to calculate control rod worth in PWR's has been studied and verified by comparing the calculated results with the experimental data available in the literature. The results were found to be satisfactory and for 13 cases investigated the maximum deviation to experimental data was $^{+-}$6% on the reactivity worth.

31830 (NUCLEBRAS-CDTN—491) Thermohydraulic tests in nuclear fuel model. Ladeira, L.C.D.; Navarro, M.A. (Centro de Desenvolvimento da Tecnologia Nuclear, Belo Horizonte (Brazil)). 1984. 15p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702066.

The main experimental works performed in the Thermohydraulics Laboratory of the NUCLEBRAS Nuclear Technology Development Center, in the field of thermofluodynamics are briefly described. These works include the performing of steady-state flow tests in single tube test sections, and the design and construction of a rod bundle test section, which will be also used for those kind of tests. Mention is made of the works to be performed in the near future, related to steady-state and transient flow tests.

31831 (NUCLEBRAS-CDTN—497) Brazilian-German investigations of thorium utilization in KWU type PWRs. Results of nuclear core design. Schlosser, G.J.; Andrade, E.P.; Carneiro, F.A.N. (Centro de Desenvolvimento da Tecnologia Nuclear, Belo Horizonte (Brazil)). 1985. 29p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702067.

The current status is presented of the ongoing investigations related to nuclear design of Th - based fuel assemblies and PWR cores.

31832 (TVA/ONRED/WRF—86/1a) Preoperational assessment of water quality and biological resources of Guntersville Reservoir in the vicinity of Bellefonte Nuclear Plant, 1974-1984. Volume 1. Barr, W.C.; Craven, T.M.; Pasch, R.W.; Poe, M.L.; Stalcup, S.B. Jr.; Tennessen, K.J.; Wade, D.C.; Wallus, R.; Webb, D.H.; West, S.L. (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). Oct 1985. 488p. NTIS, PC A21/MF A01. File Number DE86901269.

Baseline aquatic conditions in the vicinity of TVA's Bellefonte Nuclear Plant (BLN) are described for the period 1974 through 1984 with regard to spatial, seasonal, and temporal observations. Results from all instream preoperational monitoring activities are presented. Included are assessments of physical reservoir data, water quality data, and descriptions of aquatic flora (phytoplankton, periphyton, aquatic macrophytes) and fauna (zooplankton, benthic macroinvertebrates, planktonic, juvenile and adult fish). Spatial analyses indicated greater abundance of planktonic organisms from habitat along the left descending overbanks than in the mainstream river channel. An opposite trend was indicated for periphyton. Phytoplankton abundance and relative amounts of bluegreen algae were greatest at overbank and channel stations downstream of BLN. Greatest zooplankton abundance (both habitats) occurred opposite the BLN site with significantly fewer organisms at the upstream control station. Ichthyoplankton data identified the Tennessee River upstream of BLN as an important spawning area for Polyodon spathula (paddlefish) and Stizostedion canadense (sauger). High densities of freshwater drum eggs were also observed in the vicinity of BLN and upstream. Consistent spatial trends were not observed for aquatic macrophytes and most fish species.

31833 (TVA/ONRED/WRF—86/1b) Preoperational assessment of water quality and biological resources of Guntersville Reservoir in the vicinity of Bellefonte Nuclear Plant, 1974-1984. Volume 2. Tables. (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). Oct 1985. 387p. NTIS, PC A17/MF A01. File Number DE86901270.

Baseline aquatic conditions in the vicinity of TVA's Bellefonte Nuclear Plant (BLN) are described for the period 1974 through 1984 with regard to spatial, seasonal, and temporal observations. Results from all instream preoperational monitoring activities are presented. Included are assessments of physical reservoir data, water quality data, and descriptions of aquatic flora (phytoplankton, periphyton, aquatic macrophytes) and fauna (zooplankton, benthic macroinvertebrates, planktonic, juvenile and adult fish). Spatial analyses indicated greater abundance of planktonic organisms from habitat along the left descending overbanks than in the mainstream river channel. An opposite trend was indicated for periphyton. Phytoplankton abundance and relative amounts of bluegreen algae were greatest at overbank and channel stations downstream of BLN. Greatest zooplankton abundance (both habitats) occurred opposite the BLN site with significantly fewer organisms at the upstream control station. Ichthyoplankton data identified the Tennessee River upstream of BLN as an important spawning area for Polyodon spathula (paddlefish) and Stizostedion canadense (sauger). High densities of freshwater drum eggs were also observed in the vicinity of BLN and upstream. Consistent spatial trends were not observed for aquatic macrophytes and most fish species.

31834 (TVA/ONRED/WRF—86/1c) Preoperational assessment of water quality and biological resources of Guntersville Reservoir in the vicinity of Bellefonte Nuclear Plant, 1974-1984. Volume 3. Appendices. (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). Oct 1985. 329p. NTIS, PC A15/MF A01. File Number DE86901271.

Baseline aquatic conditions in the vicinity of TVA's Bellefonte Nuclear Plant (BLN) are described for the period 1974 through 1984 with regard to spatial, seasonal, and temporal observations. Results from all instream preoperational monitoring activities are presented. Included are assessments of physical reservoir data, water quality data, and descriptions of aquatic flora (phytoplankton, periphyton, aquatic macrophytes) and fauna (zooplankton, benthic macroinvertebrates, planktonic, juvenile and adult fish). Spatial analyses indicated greater abundance of planktonic organisms from habitat along the left descending overbanks than in the mainstream river channel. An opposite trend was indicated for periphyton. Phytoplankton abundance and relative amounts of bluegreen algae were greatest at overbank and channel stations downstream of BLN. Greatest zooplankton abundance (both habitats) occurred opposite the BLN site with significantly fewer organisms at the upstream control station. Ichthyoplankton data identified the Tennessee River upstream of BLN as an important spawning area for Polyodon spathula (paddlefish) and Stizostedion canadense (sauger). High densities of freshwater drum eggs were also observed in the vicinity of BLN and upstream. Consistent spatial trends were not observed for aquatic macrophytes and most fish species.

31835 (UFRJ-COPPE-PEN—130) Sensitivity calculation of the coolant temperature regarding the thermohydraulic parameters. Andrade Lima, F.R. de; Silva, F.C. da; Thome Filho, Z.D.; Alvim, A.C.M.; Oliveira Barroso, A.C. de. (Rio de Janeiro Univ. (Brazil). Coordenacao dos Programas de Pos-graduacao de Engenharia). 1985. 119p. (In Portuguese). NTIS (US Sales Only), PC A06/MF A01. File Number DE86702068.

The application is studied of the Generalized Perturbation Theory (GPT) in the sensitivity calculation of thermalhydraulic problems, aiming at verifying the viability of the extension of the method. For this, the axial distribution, transient, of the coolant temperature in a PWR channel are considered. Perturbation expressions are developed using the GPT formalism, and a computer code (Tempera) is written, to calculate the channel temperature distribution and the associated importance function, as well as the effect of the thermalhydraulic parameters variations in the coolant temperature (sensitivity calculation). The results are compared with those from the direct calculation.

31836 **Neutron dosimetry with solid-state track recorders in the Three-Mile Island Unit-2 reactor cavity.** Gold, R.; Roberts, J.H.; Ruddy, F.H.; Preston, C.C.; McElroy, W.N.; Rao, S.V.; Greenborg, J.; Fricke, V.R. (Hanford Engineering Development Lab., Richland, WA, USA; General Public Utilities Nuclear Corp., Middletown, PA, USA; Burns and Roe, Inc., Middletown, PA, USA. Three-Mile Island Unit 2). *Nuclear Tracks;* **10**: No. 3, 447-459(1985). (CONF-8407162—).

From Fission-track dating workshop; Troy, NY, USA (31 Jul 1984).

Solid-state track recorded (SSTR) neutron dosimetry has been conducted in the Three-Mile Island Unit-2 (TMI-2) reactor cavity (i.e., the annular gap between the pressure vessel and the biological shield) for nondestructive assessment of the fuel distribution. Two axial stringers were deployed in the annular gap with 17 SSTR dosimeters located on each stringer. SSTR experimental results reveal that neutron streaming, upward from the bottom of the reactor cavity region, dominates the observed neutron intensity. These absolute thermal neutron flux observations are consistent with the presence of a significant amount of fuel debris lying at the bottom of the reactor vessel. A conservative lower bound estimated from these SSTR data implies that at least 2 tonnes of fuel, which is roughly 4 fuel assemblies, is lying at the bottom of the vessel. The existence of significant neutron streaming also explains the high count rate observed with the source range monitors (SRMs) that are located in the TMI-2 reactor cavity.

31837 **Characterization of LWR spent fuel approved testing materials for radionuclide release studies.** Barner, J.O.; Daniel, J.L. (Pacific Northwest Lab., Richland, WA). pp 729-734 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Materials Characterization Center (MCC) provides characterized lightwater reactor (LWR) spent fuel approved testing materials (ATMs) for use by experimenters in radionuclide release studies in support of repository licensing efforts. The characterization completed to date is described for MCC ATM-101, a Zircaloy-clad UO_2 fuel from the H.B. Robinson, Unit 2, Assembly BO-5. ATM-101 is a moderate burnup, low-releasing (fission products in-reactor) spent fuel typical of the fuel that is expected to initially be placed in a repository.

2103 Power Reactors, Non-breeding, Graphite Moderated

REFER ALSO TO CITATION(S) 31803, 31893

2104 Power Reactors, Non-breeding, Otherwise Moderated Or Unmoderated

REFER ALSO TO CITATION(S) 31798, 31801, 31883, 31884

2105 Power Reactors, Breeding

REFER ALSO TO CITATION(S) 31913, 31914, 31915, 31916, 31917, 31918, 31919, 31920, 31921, 31922, 31924, 31928, 31932, 31938, 31940, 31941

31838 **(AEEW-R—1966) Analysis of limit cycling on a boiler feedwater control system.** Thomas, P.J.; Harrison, T.A.; Hollywell, P.D. (UKAEA Atomic Energy Establishment, Winfrith. Control and Instrumentation Div.). Jun 1985. 12p. (CONF-851022—1). Atomic Energy Establishment, Winfrith Dorchester, Dorset, England. File Number TI86901230.

From BNES conference on boiler dynamics and control in nuclear power stations; Yorkshire, UK (21 Oct 1985).

During operation of the UKAEA Prototype Fast Reactor, it was found that oscillations sometimes occurred in the boiler feedwater system. These were normally of relatively low amplitude, but led to the adoption of low controller gains so that control was rather slack. While control performance proved generally adequate for steady running, the lack of tight control of steam drum levels sometimes led to difficulties during periods when plant conditions were undergoing major change. The paper discusses the methods used to gain a full understanding of the phenomena occurring, and describes how that knowledge is being used to improve the control system so as to eliminate the limit cycling modes and ensure good control of steam drum levels. A noteworthy feature of the study was the use of two independent representations of plant behaviour: (1) a frequency response model, FWRFREQ, and (2) a time-domain simulation model, PFRTDM. The simplified analysis of FWRFREQ proved to be of enormous value in identifying modes of system behaviour; PFRTDM was used as a detailed check on the accuracy and validity of the results obtained. 14 figs.

31839 **(AEEW-R—1967) Dynamic interactions between recirculation boilers connected in parallel.** Harrison, T.A.; Thomas, P.J. (UKAEA Atomic Energy Establishment, Winfrith. Control and Instrumentation Div.). Jun 1985. 12p. (CONF-851022—2). Atomic Energy Establishment, Winfrith Dorchester, Dorset, England. File Number TI86901231.

From BNES conference on boiler dynamics and control in nuclear power stations; Yorkshire, UK (21 Oct 1985).

The UKAEA Prototype Fast Reactor (PFR) has three forced recirculation boilers employing steam drum separators. Oscillations of drum water level have been observed with the levels of all three drums moving in phase, and on occasions with one drum out of phase with the others: antiphase oscillations. An explanation of the antiphase oscillations is described which has its roots in the theory originally developed to describe parallel tube instability in once-through boilers. Here that theory is extended to cover the case of parallel boilers of the recirculation type, each with its own (nonlinear) level control system. 14 figs.

31840 **(ANL—86-11) Leakage flow-induced vibrations for variations of a tube-in-tube slip joint.** Mulcahy, T.M. (Argonne National Lab., IL (USA)). Jan 1986. Contract W-31-109-ENG-38. 39p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010765.

Variations in the design of a specific slip joint separating two cantilevered, telescoping tubes conveying water were studied to determine their effect upon the leakage flow-induced vibration self-excitation mechanism known to exist for the original slip joint geometry. The important parameters controlling the self-excitation mechanism were identified, which, along with previous results, allowed the determination of a comprehensive set of design rules to avoid unstable vibrations. This was possible even though a new self-excitation mechanism was found when the engagement of the two tubes was small. 9 refs.

31841 **(ANL—86-21) Instability characteristics of fluidelastic instability of tube rows in crossflow.** Chen, S.S.; Jendrzejczyk, J.A. (Argonne National Lab., IL (USA)). Apr 1986. Contract W-31-109-ENG-38. 32p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86007852.

An experimental study is reported to investigate the jump phenomenon in critical flow velocities for tube rows with different pitch-to-diameter ratios and the excited and intrinsic instabilities for a tube row with a pitch-to-diameter ratio of 1.75. The experimental data provide additional insights into the instability phenomena of tube arrays in crossflow. 9 refs., 10 figs.

31842 **(CONF-860422—1) Integral Fast Reactor concept.** Till, C.E.; Chang, Y.I. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010502.

From American power conference; Chicago, IL, USA (14 Apr 1986).

The Integral Fast Reactor (IFR) is an innovative LMR concept, being developed at Argonne National Laboratory, that fully exploits the inherent properties of liquid metal cooling and metallic fuel to achieve breakthroughs in economics and inherent safety. This paper describes key features and potential advantages of the

IFR concept, technology development status, fuel cycle economics potential, and future development path.

31843 (CONF-8604117—5) Summary of the Hot Fuel Examination Facility's Neutron Radiography Reactor's first eight years. Pruett, D.P.; McClellan, G.C.; Heidel, C.C.; Weeks, A.A. (Argonne National Lab., Idaho Falls, ID (USA)). 1986. Contract W-31-109-ENG-38. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010503.

From 10. U.S. TRIGA user's conference; College Station, TX, USA (7 Apr 1986).

Information is presented on the operation of the Neutron Radiography Reactor. The Neutron Radiography Reactor (NRAD) is located in the Hot Fuel Examination Facility (HFEF) at Argonne National Laboratory - West. HFEF comprises several large hot cells where both non-destructive and destructive examinations of highly irradiated reactor fuels are conducted in support of the LMFBR program. One of the non-destructive examination techniques utilized at HFEF is neutron radiography.

31844 (IAE—3996/4) Analysis of breeding performances of the steam cooled fast reactor. Kalafati, D.D.; Slesarev, I.S.; Stukalov, V.A.; Shchepetina, T.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 23p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702069.

Main neutron-physical performances of a fast reactor cooled by superheated steam are considered. The dependences of breeding ratio, fuel doubling time, critical loading on geometric core parameters (core length, fuel elements relative lattice pitch) and steam coolant density as well as on the size and composition of end shields are investigated. The converter mode of such reactor operation is considered. The data on the coolant composition and structural material effect on breeding are given. The breeding ratio may vary depending on core parameters from 1.07 to 1.37. The converter operation mode ensures the conversion ratio from 0.8 to 0.9.

31845 (IAE—3997/4) Prospects of breeding improvements in steam cooled fast reactors with the heterogeneous cores. Kalafati, D.D.; Morozov, A.G.; Slesarev, I.S.; Shchepetina, T.D. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702070.

The characteristics of breeding of the steam cooled fast reactor with the heterogeneous core lay-out in which fuel assemblies with enriched fuel and fossil material alternate in an established order and ratio are considered. The characteristics are investigated depending on the core heterogeneity degree (typical size of fuel module) and the part of fossil material. Such form of heterogeneity is most promising for raising the breeding level in a steam cooled fast reactor.

31846 (WAPD-TM—1547) Production irradiated fuel assay gauge neutron detection: description and testing (LWBR Development Program). Tessler, G. (Bettis Atomic Power Lab., West Mifflin, PA (USA)). Apr 1986. Contract AC11-76PN00014. 86p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010643.

The production irradiated fuel assay gauge (PIFAG) is being used to nondestructively assay irradiated LWBR core fuel rods by the method of active neutron interrogation with delayed neutron counting. Twenty delayed neutron detectors have been assembled, fifteen for use in the PIFAG and five spares. A delayed neutron detector assembly consists of four ^{10}B-lined proportional counters connected in parallel to a common preamplifier. The preamplifier utilizes an LD604 hybrid circuit and is located within the detector assembly. An extensive test program has been carried out to measure detector properties and performance. The properties investigated include the sensitivity of delayed neutron detectors' count rate to small changes in applied bias, small angle rotation of the detector assembly about its axis, temperature of the preamplifier, temperature of the ^{10}B-lined proportional counters, temperature of the polyethylene medium containing the detectors and the ^{238}PuBe source used for detector testing, and small changes in applied preamplifier threshold voltage. Twelve miniature fission counters, four for the PIFAG and eight spares, have been procured to measure interrogation source neutrons close to the surface of a fuel rod as the rod passes through the PIFAG source region. These counters are sensitive to the materials in the fuel rod and provide a measure of the axial distribution of fuel in the rod. Fission counter testing was limited by low count rates. Sufficient data were obtained, however, to show that all detectors and electronics perform satisfactorily. 30 figs., 11 tabs.

31847 A wide-range vortex shedding flowmeter for high temperature helium gas. Baker, S.P.; Herndon, P.G.; Ennis, R.M. Jr. (Oak Ridge National. Lab., Instrumentation and Controls Div., P.O. Box X, Oak Ridge, TN 37830). pp 1401-1432 of Advances in instrumentation. Volume 38. Research Triangle Park, NC; Instrument Society of America (1983). (CONF-8310102—). Contract W-7405-ENG-26.

From Instrument Society of America conference and exhibit; Houston, TX, USA (10 Oct 1983).

The existing design of a commercially available vortex shedding flowmeter (VSFM) was modified and optimized to produce three 4-in. and one 6-in. high performance VSFMs for measuring helium flow in a gas-cooled fast reactor (GCFR) test loop. The project was undertaken because of the significant economic and performance advantages to be realized by using a single flowmeter capable of covering the 166:1 flow range (at 350°C and 45:1 pressure range) of the tests. A detailed calibration in air and helium at the Colorado Engineering Experiment Station showed an accuracy of +.1% of reading for a 100:1 helium flow range and +.1.75% of reading for a 288:1 flow range in both helium and air. At an extended gas temperature of 450°C, water cooling was necessary for reliable flowmeter operation.

2106 Power Reactors, Auxiliary, Mobile, Package, And Transportable

REFER ALSO TO CITATION(S) 31896

31848 Space nuclear power systems 1984; Proceedings of the first symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Melabar, FL; Orbit Book Co., Inc. (1985). 613p. (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

Various papers on space nuclear power systems are presented. The general topics addressed are: programmatics, power systems integration and control, systems concepts, reactors, materials and energy conversion, thermal management, and safety and reliability. Individual papers on subjects such as the past, present, and future of space nuclear power programs, space systems architecture, and civilian and military applications of space nuclear power are also presented.

31849 Space Shuttle integration considerations for nuclear power system. Major, A.L.; Vivona, A.A.,JR. (Martin Marietta Corp., Denver, CO). pp 87-91 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

There is renewed national interest in developing nuclear space power generation technology for the 1990s. The program objective calls for a prototype 100 kW unit in space by 1995. One conceptual design envisions a unit of approximately 3000 kg with a 6 meter length and 4 1/2 meter diameter. The nuclear subsystem mass (reactor, heat pipes and radiation shield) accounts for approximately 70 percent of the power unit's weight. Airborne Support Equipment (ASE) includes the cargo bay cradles to support the space power system within the Space Transportation System (STS) Orbiter cargo bay. Department of Defense (DOD) potential applications for nuclear space power include directed-energy weapons, electronics jamming, and surveillance operations. The National Aeronautics and Space Administration (NASA) envisions such use

in providing electrical power for space stations, lunar operations, and deep planetary explorations. This paper examines some integration issues involved in using the STS and focuses on safety considerations. 14 references.

31850 **Reactor power system deployment and startup.** Wetch, J.R.; Nelin, C.J.; Britt, E.J.; Klein, G. (Space Power, Inc., Sunnyvale, CA; Rasor Associates, Inc., Sunnyvale, CA; California Institute of Technology, Pasadena). pp 93-108 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

This paper addresses issues that should receive further examination in the near-term as concept selection for development of a U.S. space reactor power system is approached. The issues include: the economics, practicality and system reliability associated with transfer of nuclear spacecraft from low earth shuttle orbits to operational orbits, via chemical propulsion versus nuclear electric propulsion; possible astronaut supervised reactor and nuclear electric propulsion startup in low altitude Shuttle orbit; potential deployment methods for nuclear powered spacecraft from Shuttle; the general public safety of low altitude startup and nuclear safe and disposal orbits; the question of preferred reactor power level; and the question of frozen versus molten alkali metal coolant during launch and deployment. These issues must be considered now because they impact the SP-100 concept selection, power level selection, weight and size limits, use of deployable radiators, reliability requirements, and economics, as well as the degree of need for and the urgency of developing space reactor power systems. 5 references.

31851 **Autonomous control design considerations for space nuclear power systems.** Imamura, M.S.; Masson, J.H. (Martin Marietta Corp., Denver, CO). pp 115-125 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

This paper describes the application of automated power system technology to a nuclear space power system. Autonomous operation is defined as the act of performing all functions with no ground or human intervention for a specified duration of time. A desirable operational requirement for a nuclear power system is that the system operates autonomously for periods of up to 30 days with an operational life of up to seven years and total orbital life of ten years. This type of autonomy requirement, along with a long mission lifetime, is the principal driver in identifying the functional requirements and the resulting control subsystem configuration and monitoring and control software strategies. All functions to be done automatically are classified into data handling, monitoring, routine control, fault handling, and mission control operations. Data handling consists of acquisition, processing, and storage of data; monitoring includes operational state and state of health determination and built-in test and checkout; routine control includes all housekeeping or maintenance control activities; and the planning and operations task basically involves the management of power/energy capability and utilization (load management) of not only the nuclear power source but also the auxiliary power supplies and batteries serving the nuclear system. 5 references.

31852 **Reactor power system/spacecraft integration.** Elms, R.V. (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA). pp 127-136 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

The new national initiative in space reactor technology evaluation and development is strongly tied to mission applications and to spacecraft and space transportation system (STS) compatibility. This paper discusses the power system integration interfaces with potential using spacecraft and the STS, and the impact of these requirements on the design. The integration areas of interest are mechanical, thermal, electrical, attitude control, and mission environments. The mission environments include space vacuum, solar input, heat sink, space radiation, weapons effects, and reactor power system radiation environments. The natural, reactor, and weapons effects radiation must be evaluated and combined to define the design requirements for spacecraft electronic equipment. 7 references.

31853 **Approach to space reactor system selection and design.** Buden, D.; Lee, J.H. Jr. (Science Applications International Corp., Albuquerque, NM; DNA, Kirtland AFB, NM). pp 139-147 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

The rudiments of a methodology to select design concepts for high performance, compact space reactors is developed. This methodology starts with defining a set of requirements to be used as a basis for the design decision. Technology options are then delineated. These must be carefully defined so that the options give a true measure for comparison. Only those options that meet or exceed all requirements are to be used in the next phase of the selection process. Here, a systematic approach to making a decision, such as multi-attribute decision theory, is used. This forces one to decide the relative importance of various requirements and to evaluate how well each concept meets the requirements. The output should be used as a guide for determining the final rankings. Finally, since the projected mission requirements tend to be generic, the sensitivity of these rankings to changes in mission requirements should be evaluated.

31854 **Evolution of systems concepts for a 100 kWe class space nuclear power system.** Katucki, R.; Josloff, A.; Kirpich, A.; Florio, F. (General Electric Co., Valley Forge, PA). pp 149-164 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

Conceptual designs for the SP-100 space nuclear power system have been prepared that meet baseline, backup and growth program scenarios. Near-term advancement in technology was considered in the design of the baseline concept. An improved silicon-germanium thermoelectric technique is used to convert the heat from a fast-spectrum, liquid lithium cooled reactor. This system produces a net power of 100 kWe with a 10-year end of life, under the specific constraints of area and volume. Output of the backup concept is estimated to be 60 kWe for a 10-year end of life. This system differs from the naseline concept because currently available thermoelectric conversion is used from energy supplied by a liquid sodium cooled reactor. The growth concept uses Stirling engine conversion to produce 100 kWe within the constraints of mass and volume. The growth concept can be scaled up to produce a 1 MWe output that uses the same type reactor developed for the baseline concept. Assessments made for each of the program scenarios indicate the key development efforts needed to initiate detailed design and hardware program phases. Development plans were prepared for each scenario that detail the work elements and show the program activities leading to a state of flight readiness.

31855 **Rockwell SR-100G reactor turboelectric space power system.** Anderson, R.V. (Rockwell International Corp., Canoga Park, CA). pp 165-175 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

During FY 1982 and 1983, Rockwell International performed system and subsystem studies for space reactor power systems. These studies drew on the expertise gained from the design and flight of the SNAP-10A space nuclear reactor system. These studies, performed for the SP-100 Program, culminated in the selection of a reactor-turboelectric (gas Brayton) system for the SP-100 application; this system is called the SR-100G. This paper describes the features of the system and provides references where more detailed information can be obtained.

31856 **Gas cooled reactor concepts for space applications.** Pierce, B.L. (Westinghouse Electric Corp., Pittsburgh, PA). pp 191-196 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

Three compact high performance gas cooled nuclear reactor concepts are investigated: the NERVA Derivative Reactor (NDR) which is based on the ROVER/NERVA technology, the Fixed Bed Reactor (FBR) where fuel beads are packed into an annular bed between two porous cylindrical frits, and the Rotating Bed Reactor (RBR) where fuel beads are held inside a rotating porous cylindrical frit. The assumed space application is for hydrogen cooled reactors that operate for short periods of time at high power levels. The NDR can achieve the space nuclear reactor performance requirements with less investment, time and risk because it builds on the extensive technology demonstrated in the ROVER/NERVA program. 5 references.

31857 **Thermionic reactors for space nuclear power.** Homeyer, W.G.; Merrill, M.H.; Holland, J.W.; Fisher, C.R.; Allen, D.T. (GA Technologies, Inc., San Diego, CA). pp 197-205 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

Thermionic reactor designs for a variety of space power applications spanning the range from 5 kWe to 3 MWe are described. In all of these reactors, nuclear heat is converted directly to electrical energy in thermionic fuel elements (TFEs). A circulating reactor coolant carries heat from the core of TFEs directly to a heat rejection radiator system. The recent design of a thermionic reactor to meet the SP-100 requirements is emphasized. Design studies of reactors at other power levels show that the same TFE can be used over a broad range in power, and that design modifications can extend the range to many megawatts. The design of the SP-100 TFE is similar to that of TFEs operated successfully in test reactors, but with design improvements to extend the operating lifetime to seven years. 13 references.

31858 **Liquid metal cooled reactors for space power applications.** Bailey, S.; Vaidyanathan, S.; Van Hoomissen, J. (General Electric Co., Sunnyvale, CA). pp 207-215 of Space nuclear power systems 1984; Proceedings of the First Symposium, Albuquerque, NM, January 11-13, 1984. Volumes 1 & 2. El-Genk, M.S.; Hoover, M.D. Malabar, FL; Orbit Book Co., Inc. (1985). (CONF-840113—).

From Symposium on space nuclear power systems; Albuquerque, NM, USA (10 Jan 1984).

The technology basis for evaluation of liquid metal cooled space reactors is summarized. Requirements for space nuclear power which are relevant to selection of the reactor subsystem are then reviewed. The attributes of liquid metal cooled reactors are considered in relation to these requirements in the areas of liquid metal properties, neutron spectrum characteristics, and fuel form. Key features of typical reactor designs are illustrated. It is concluded that liquid metal cooled fast spectrum reactors provide a high confidence, flexible option for meeting requirements for SP-100 and beyond.

2107 Regulation And Licensing

REFER ALSO TO CITATION(S) 31876, 31891, 31956

31859 **(NUREG—0750-Vol.23-No.2) Nuclear Regulatory Commission Issuances. Volume 23, No. 2.** (Nuclear Regulatory Commission, Washington, DC (USA). Div. of Technical Information and Document Control). Feb 1986. 69p. NTIS, PC A04/MF A01 - GPO. File Number TI86901241.

This report includes the issuances received during the specified period from the Commission (CLI), the Atomic Safety and Licensing Appeal Boards (ALAB), the Atomic Safety and Licensing Boards (LBP), the Administrative Law Judge (ALJ), the Directors' Decisions (DD), and the Denials of Petitions for Rulemaking (DPRM).

31860 **(NUREG/CR—3959) Transition to an operating reactor environment: implications for NRC quality assurance programs based on nuclear power industry and regulatory projections through 1995.** Christensen, J.A.; Schuller, C.R.; Harty, H.; Patrick, M.G. (Pacific Northwest Labs., Richland, WA (USA)). Mar 1986. Contract AC06-76RL01830. 111p. (PNL—5769). NTIS, PC A06/MF A01 - GPO. File Number TI86009172.

This report develops projections for nuclear power plant regulatory needs in general, and those relating to quality assurance in particular, for the time period 1985 to 1995. This required an assessment of future prospects for the nuclear power industry and its primary segments. Electric power demand projections and their relationship to estimated schedules for nuclear plant construction and operations were evaluated, and estimates of anticipated business volume and long-term economic viability were made for each of the major segments of the US nuclear industry (utilities, NSSS vendors, AEs, constructors, component suppliers, and service vendors). These estimates were made for two, five and ten year intervals through 1995. Other significant factors that are not specific to any one industry segment were also reviewed. These included: (1) the expanding foreign presence in US markets; (2) pending legislations; (3) trends in personnel availability; (4) new institutional arrangements for nuclear power generation; (5) nuclear plant aging, life extension, and decommissioning; (6) reactivation of mothballed projects; (7) advanced and standardized plant designs; and (8) likely technological development in computer applications and inspections methods.

2108 Economics

31861 **(AREAEE—272) On the evaluation of feed requirements and costs analysis of preirradiated fuel cycle operations for uranium fuelled light water reactors.** El Osery, I.A.; Yasso, K.A.; Abdel Salam, A.S. (Nuclear Research Centre, Inshas (Egypt)). 1982. 22p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702091.

This work is a part of an integrated scheme for nuclear power cost evaluation. The paper gives a brief description of the different operations included to get enriched UO_2 in its final form. A Material Balance Sheet is developed to estimate quantitatively the input material requirements to each fuel operation. An improved approach for fuel cost analysis is developed. The paper includes a complete FORTRAN listing for the computer program carried out for this purpose together with description of the program input data requirements and output facilities. Illustrative numerical results are provided.

31862 **(GA-A—18269) Nuclear power investment risk economic model.** Houghton, W.J.; Postula, F.D. (GA Technologies, Inc., San Diego, CA (USA)). Dec 1985. Contract AC03-84SF11963. 24p. (CONF-860683—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007296.

From 30. annual meeting of the American Association of Cost Engineers; Chicago, IL, USA (29 Jun 1986).

This paper describes an economic model which was developed to evaluate the net costs incurred by a utility due to an accident induced outage at a nuclear power plant. During such an

outage the portion of the plant operating costs associated with power production are saved; however, the owning utility faces a sizable expense as fossil fuels are burned as a substitute for the incapacitated nuclear power. Additional expenses are incurred by the utility for plant repair and if necessary, decontamination costs. The model makes provision for mitigating these costs by sales of power, property damage insurance payments, tax write-offs and increased rates. Over 60 economic variables contribute to the net cost uncertainty. The values of these variables are treated as uncertainty distributions and are used in a Monte carlo computer program to evaluate the cost uncertainty (investment risk) associated with damage which could occur from various categories of initiating accidents. As an example, results of computations for various levels of damage associated with a loss of coolant accident are shown as a range of consequential plant downtime and unrecovered cost. A typical investment risk profile is shown for these types of accidents. Cost/revenue values for each economic factor are presented for a Three Mile Island - II type accident, e.g., uncontrolled core heatup. 4 refs., 6 figs., 3 tabs.

22 NUCLEAR REACTOR TECHNOLOGY

31863 (ENEA-RT/ING—82-24) ENEA version of the lagrangian code ASTARTE-4 later developments and user's manual modifications. Cigarini, M.; Daneri, A.; Toselli, G.; Zucchini, A. (ENEA, Bologna (Italy). Dipartimento Tecnologie Intersettoriali di Base). Sep 1982. 27p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86901380.

In this report, modifications made to ASTARTE-4 lagrangian code since 1979 (year since which it is operative at ENEA computer Center) up to now (1982), are presented. Namely, modifications concerning internal and boundary thin structures constituted by different materials and those concerning mesh manual << Rezoning>> facility are described. Finally the new instructions for input data preparation regarding modified code sections are presented.

2201 Theory And Calculation

31864 (AAEC/E—618) MCRP - a Monte Carlo resonance program for neutrons slowing down in single rod and rod cluster lattices. Doherty, G.; Robinson, G.S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Sep 1985. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702045.

MCRP is a Monte Carlo computer program for tracking neutrons slowing down in single rod and rod cluster lattices. The code is intended for calculations of resonance absorption in reactor fuel nuclides using cross sections at 124,000 energy points below 20 keV. The only intrinsic assumptions are that scattering is both elastic and isotropic in the centre of mass system.

31865 (AEEW-R—1714) Fast fission ratio and relative conversion ratio measurements in gadolinium poisoned water moderated UO_2 lattices. Murphy, M.F. (UKAEA Atomic Energy Establishment, Winfrith). Jan 1984. 52p. H.M. Stationery Office, London, price Pound 5.00.

This report deals with measurements from criticality experiments carried out for BNFL in the Battelle Reactor Facility. Foils were prepared at Winfrith, and were returned some 28 hours after irradiation for counting. It was therefore necessary to modify the counting technique, and this is described. Results are presented.

31866 (INIS-BR—458) Development of a calculation method for one dimensional kinetic analysis in fission reactors, with feedback effects. Paixao, S.B. (Instituto Militar de Engenharia, Rio de Janeiro (Brazil)). 1985. 112p. (In Portuguese). NTIS (US Sales Only), PC A06/MF A01. File Number DE86702046.

The methodology used in the WIGLE3 computer code is studied. This methodology has been applied for the steady-state and transient solutions of the one-dimensional, two-group, diffusion equations in slab geometry, in axial type probelm analysis. Also studied, based in a WIGLE3 computer code, are reactor representative models considering non-boiling heat transfer. A steady-state program for control rod bank position search- CITER 1D- has been developed. Some criticality research on the proposed system has been done using different control rod bank initial positions, time steps and convergence parameters.

31867 (LCC—004/85) Problem of atomic diffusion in a moving boundary. Numerical study. Bezerra, M.C.C. (Laboratorio de Computacao Cientifica, Rio de Janeiro (Brazil)). 1985. 11p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702047.

The convergence is analysed of a numerical scheme for calculating approximate solutions of a model used for evaluating concentration of atoms in a diffusion process in the walls of nuclear reactors. The ion trapping process is admitted to be reversible and the wall corrosion process is also considered in the model so that it must deal with a moving boundary. Some conditions for the motion of the boundary are established in such a way that convergence can be assured in more general settings than those of previous papers.

31868 (NUREG/CR—4349) LSL-M2: a computer program for least-squares logarithmic adjustment of neutron spectra. Stallmann, F.W. (Oak Ridge National Lab., TN (USA)). Mar 1986. Contract AC05-84OR21400. 107p. (ORNL/TM—9933). NTIS, PC A06/MF A01 - GPO. File Number TI86008413.

LSL-M2 is a package of computer programs for the adjustment of neutron spectra in nuclear reactors based on the combination of neutron transport calculations and radiometric or other integral dosimetry measurements and their uncertainties in the form of variances and correlations. The underlying algorithm is a least squares logarithmic statistical estimation procedure. Spectra at several different locations can be processed simultaneously which increases the accuracy of the adjusted values and allows the adjustment of spectra at locations without dosimetry. The primary output is adjusted damage parameter values (e.g., fluence > 1.0 MeV and dpa) with uncertainties. The code is written in standard FORTRAN-77 and has been tested for the DEC-10 and the IBM-PC/AT. Requests for the computer code and associated data files should be made through A. Taboada, US Nuclear Regulatory Commission, Mail Code NL 5650, Washington, DC 20555. 15 refs.

31869 (UJV—7032-T) Calculation of effective lateral heat conductivity coefficient in regular triangular and square lattices. Smid, J. (Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)). Oct 1984. 25p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702048.

Several programs have been developed for the computation, which may be divided into three groups: programs for data preparation, programs for actual computation and programs for data control and graphic representation. The diagram shows the interlinkage of the individual programs. The computations were made for two types of fuel rods: the first type had the outer diameter 6.9 and wall thickness 0.4, the second type had an outer diameter of 14.0 and wall thickness 2.0. For the first type of rod a relative step of 1.01 and 1.05 was considered for the relative value of thermal conductivity coefficients of the medium inside and outside the pipe equal 3.00, and 1.10 and 1.15 for value of the coefficients 1.00. Relative steps of 1.20 and 1.30 were considered for the second type of fuel rods for the relative value of thermal conductivity coefficients inside and outside the pipe equal 0.20, and steps of 1.40 and 1.50 for coefficient values 0.02. The values of thermal conductivity coefficients were expressed relative to the coefficient of the fuel rod wall for which the value 1.00 was accepted. Tabulated are the results of variants for triangular lattices of the type 1 x 1, 2 2, 3 x 3, 4 x 4, and for square lattices of the 2 x 2, 4 x 3 and 6 x 4 types. The configurations of lattices for different variants are represented graphically.

2202 Components And Accessories

REFER ALSO TO CITATION(S) 31892, 31944, 32218

31870 (INIS-BR—459) Temperature distribution due to the heat generation in nuclear reactor shielding. Torres, L.M.R. (Instituto Militar de Engenharia, Rio de Janeiro (Brazil)). 1985. 233p. (In Portuguese). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702051.

A study is performed for calculating nuclear heating due to the interaction of neutrons and gamma-rays with matter. Modifications were implemented in the ANISN and DOT 3.5 codes, which solve the transport equation using the discrete ordinate method, in one and two-dimensions respectively, to include nuclear heating calculations in these codes. In order to determine the temperature distribution, using the finite difference method, a numerical model was developed for solving the heat conduction equation in one-dimension, in plane, cylindrical and spherical geometries, and in two-dimensions, X-Y and R-Z geometries. Based on these models, computer programs were developed for calculating the temperature distribution. Tests and applications of the implemented modifications were performed in problems of nuclear heating and temperature distribution due to radiation energy deposition in fission and fusion reactor shields.

2203 Fuel Elements

31871 (IAEA-TECDOC—356, pp 189-209) Behaviour of fuel cladding under accident conditions. Bairiot, H.; Vliet, J. van. Nov 1985. NTIS (US Sales Only), PC A10/MF A01. File Number DE86702053.

In Fuel cladding interaction with water coolant in power reactors. A survey report of a co-ordinated research programme on the investigation of fuel element cladding interaction with water coolant in power reactors.

The behaviour of the fuel cladding during accidental transients is a key phenomenon which determines whether an actual or a design basis accident will or will not lead to activity release to the coolant or to the environment; it determines also the extent of core damage which can possibly penalize further power plant operation. In off-normal and accidental situations, a strong chemical interaction may arise between Zircaloy and coolant. This results essentially from the chemical affinity of Zircaloy for oxygen, together with the thermodynamic conditions of the interaction. It is the objective of the present chapter to review this type of interaction, on the basis of some recent publications.

31872 (IAEA-TECDOC—356, pp 213-221) Design and performance considerations of coolant cladding interaction. Bairiot, H.; Lippens, M. Nov 1985. NTIS (US Sales Only), PC A10/MF A01. File Number DE86702053.

In Fuel cladding interaction with water coolant in power reactors. A survey report of a co-ordinated research programme on the investigation of fuel element cladding interaction with water coolant in power reactors.

Crud deposits and cladding corrosion directly affect the fuel rod performance by an immediate consequence which is a cladding temperature increase. The ultimate damage which results from such a temperature increase is a perforation of the cladding. In order to eliminate or at least to postpone this event, the design must define adequate specifications firstly to reduce the cladding corrosion and, secondly, to operate fuel rods with oxide layers. The first aspect is related to the fuel and assembly design, and to the operation of the primary circuit; the second aspect is related to power history (and therefore core design). The present chapter briefly summarizes the conditions which enhance crud deposition and corrosion, the consequences of corrosion and some remedies which can limit the crud deposits and cladding oxidation.

31873 (INIS-BR—462, pp 295-297) Application of the beta particles backscattering technique for determining the thickness of the cladding in nuclear fuel plates. Koshimizu, S.; Ferreira, P.I.; Lima, L.F.C.P. de; Vieira, J.M.; Perez, H.E.B. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

A prototype of an installation to measure thickness of cladding and core of nuclear fuel plates using the beta particle backscattering technique is constructed. The method and calibration system is described. The thickness measurements of the cladding and core were done in a natural uranium fuel plate developed at IPEN. The reliability of the method is confirmed by the metallographic measures analysis.

2205 Environmental Aspects

REFER ALSO TO CITATION(S) 31832, 31833, 31834, 31925, 31926, 31927, 31929, 31930, 31931, 31933, 31934, 31935, 31936, 31937, 31942, 31943, 31952, 32743

31874 (ORNL/M—140) Measurements of airborne radioactive emissions from nuclear power plants and their quality control in the Federal Republic of Germany. Winkelmann, I.; Fields, D.E. (Oak Ridge National Lab., TN (USA); Institut fuer Strahlenhygiene des Bundesundheitsamtes, Muenchen (Germany, F.R.)). Jul 1985. Contract AC05-84OR21400. 43p. Inst. for Radiation Hygiene, Ingolstaedter Landstrasse 1, D-8042, Neuherberg, Muenchen, Germany. File Number TI86009014.

Procedures have been established which govern monitoring and the detailed assessment by plant operators of gaseous radioactive releases from nuclear power plants. In presenting and describing the measuring techniques, the detection of specific radionuclides in gaseous effluents is of major importance. The description of measuring techniques is exemplified by results from emission measurements and the resulting radiation exposure to the public for the year 1983. Another main issue is the measuring program for quality control as performed by the Federal health Office for the control of balance (detailed assessment) measurements of radioactive emission in effluent air which are performed by facility operators. The measurements for the detailed assessment of radioactive emissions are supervised by an independent expert in a national standardized measuring program. This supervisory program is also discussed here. A detailed description of the routine measurement program, the comparative measurements during the starting phase of a nuclear power plant and the quality control by "round-robin-tests" is given.

31875 (PNL—5275) Environmental characterization of two potential locations at Hanford for a new production reactor. Watson, E.C.; Becker, C.D.; Fitzner, R.E.; Gano, K.A.; Imhoff, K.L.; McCallum, R.F.; Myers, D.A.; Page, T.L.; Price, K.R.; Ramsdell, J.V. (Pacific Northwest Labs., Richland, WA (USA)). Sep 1984. Contract AC06-76RL01830. 528p. NTIS, PC A23/MF A01; 1; GPO Dep. File Number DE86006925.

This report describes various environmental aspects of two areas on the Hanford Site that are potential locations for a New Production Reactor (NPR). The area known as the Skagit Hanford Site is considered the primary or reference site. The second area, termed the Firehouse Site, is considered the alternate site. The report encompasses an environmental characterization of these two potential NPR locations. Eight subject areas are covered: geography and demography; ecology; meteorology; hydrology; geology; cultural resources assessment; economic and social effects of station construction and operation; and environmental monitoring. 80 refs., 68 figs., 109 tabs.

31876 (UNI—2226) UNC environmental surveillance report for the 100 areas - FY 1982. Greager, E.M. (UNC Nuclear Industries, Inc., Richland, WA (USA)). 14 Dec 1982. Contract AC06-76RL01857. 46p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86008957.

The UNC Environmental Surveillance Program for the 100 Areas provides monitoring to assist in evaluating the environmental impact of 100-N Reactor facilities, the shutdown reactor facilities, and burial grounds in the retired 100 Areas. The surveillance program consists of sampling and monitoring of several environmental parameters. At 100-N Area, samples of ambient air, groundwater, vegetation, soil, and sediment are collected and analyzed along with direct radiation measurements around the 1301-N Facility and along the river shoreline. At the retired 100 Areas, soil and vegetation samples are collected and analyzed. Based on the sampling performed for the environmental surveillance program, 100 Area facilities are in compliance with applicable regulations and there is no significant adverse environmental impact from past or present reactor operations.

31877 (UNI—2640) UNC environmental surveillance report for the 100 Areas - FY 1983. Greager, E.M. (UNC Nuclear Industries, Inc., Richland, WA (USA)). 31 Oct 1983. Contract AC06-76RL01857. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86008956.

The UNC Environmental Surveillance Program for the 100 Areas provides monitoring to assist in evaluating the environmental impact of 100-N Reactor facilities, the shutdown reactor facilities, and burial grounds in the retired 100 Areas. The surveillance program consists of sampling and monitoring of several environmental parameters. At 100-N Area, samples of ambient air, groundwater, vegetation, soil, and sediment are collected and analyzed along with direct radiation measurements around the 1301-N Facility and along the river shoreline. At the retired 100 Areas, soil and vegetation samples are collected and analyzed. Based on the sampling performed for the environmental surveillance program, 100 Area facilities are in compliance with applicable regulations, and there is no significant adverse environmental impact from past or present reactor operations.

31878 (UNI—3069) UNC environmental surveillance report for the 100 areas - FY 1984. Greager, E.M. (UNC Nuclear Industries, Inc., Richland, WA (USA)). 21 Dec 1984. Contract AC06-76RL01857. 46p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86008955.

The UNC Environmental Surveillance Program for the 100 Areas provides monitoring to assist in evaluating the environmental impact of 100-N Reactor facilities, the shutdown reactor facilities, and burial grounds in the retired 100 Areas. The surveillance program consists of sampling and monitoring of several environmental parameters. At 100-N Area, samples of ambient air, groundwater, vegetation, soil, and sediment are collected and analyzed along with direct radiation measurements around the 1301-N Facility and along the river shoreline. At the retired 100 Areas, soil and vegetation samples are collected and analyzed. In addition, groundwater samples are collected and analyzed from several monitoring wells at 100-K Area. Special samples to monitor the potential biotransport of radionuclides may also be included in the surveillance program. Based on the sampling performed for the environmental surveillance program, 100 Area facilities are in compliance with applicable regulations and there is no significant adverse environmental impact from past or present reactor operations.

2206 Research, Test, And Experimental Reactors

31879 (AEEW-R—268) Calculations of reactivities and temperature coefficients for the U235 loadings of ZENITH. Caro Manso, R.; Reed, D.L. (UKAEA Atomic Energy Establishment, Winfrith). Jun 1963. 53p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86901187.

This paper describes theoretical calculations carried out for the ZENITH U235 loadings. Emphasis has been put on reactivities and temperature coefficients but the report also includes some work on related physical quantities such as bucklings, spectra, infinite multiplication factors and disadvantage factors.

31880 (DOE/ER/03919—T1) Nuclear Engineering Teaching Laboratory. 1985 annual report, January 1-December 31, 1985. (Texas Univ., Austin (USA). Nuclear Engineering Teaching Lab.). Jan 1986. Contract AC05-76ER03919. 75p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010286.

Information is given on the administration, development, and operations of the Nuclear Engineering Teaching Laboratory, and about laboratory inspections and public service and research activities. The major equipment of the laboratory consists of a 250 kW TRIGA Mark I reactor operated in pulsing and steady state modes. The report of facility operations includes reactor shutdowns, radiation exposures, area radiation surveys, radioactive effluents. A list is given of academic courses and research projects utilizing the reactor and associated facilities. (LEW)

31881 (IAE—4003/4) Method of fuel assembly power control by gaseous absorber for experimental study of power reactor fuel elements in the MR reactor under power transients. Andreev, V.I.; Goncharov, V.V.; Kolyadin, V.I.; Smirnov, A.I.; Yakovlev, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702072.

For performing investigations on power reactor fuel elements serviceability in the MR reactor under power transients a specialized reactor facility with autonomus power control of experimental fuel assembly using helium-3 neutron absorber has been developed and designed. The results of calculational and experimental study of possibilities of using the method of gas control in the MR reactor which are illustrated by experimental data of WWER-1000-type fuel element tests in cyclic modes are presented. The results of these investigations confirm ample opportunities of the method for power control with a helium-3 neutron gaseous absorber and the correctness of the technique selection.

31882 (IPEN-Pub—82) Application of TEMPPC code to the IEA-R1 nuclear reactor core hydrothermal calculations operating at 2 MW for determining the minimal coolant flow. Frajndlich, R.; Sousa, J.A. de. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 19p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702073.

A thermohydraulic study of the IEA-R1 nuclear reactor core on steady-state operating condition and forced convection is presented. The objective of this calculation is to obtain the minimal flow rate of coolant necessary at the reactor core, limited by the temperature associated to the beginning of nucleate boiling over the fuel plates at a normal operating power (2MW) for a certain inlet coolant temperature. The coolant system safety level is also calculated in this paper, which is divided in three steps: thermohydraulic calculation, without using the uncertainty factors and, after that, considering these factor by two methods: the statistical and the conventional ones. Whichever the method accepted, the results obtained by the program TEMPPC show a great safety margin with respect to the thermohydraulic parameters from the IEA-R1 nuclear reactor.

31883 (ITEF—62(1985)) Possibilities of power distribution smoothing in the modernized TVR-M heavy water reactor. Mikhajlov, V.M.; Myrtsymova, L.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 27p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86702074.

Possibilities of power distribution smoothing in the TVR-M research reactor are compared by means of control drives or by filling the liquid control system (LCS) channels by a moderator. The approximate equivalence of both methods is shown. For each method a neutron flux variation in the reactor reflector is determined. The conclusion is drawn that the selective filling of LCS channels by the moderator allows one to improve the power distribution field without affecting the power distribution over the core length. The radial power peak value $\mu sub(r)$ may be decreased from 1.056 to 1.039, the reactivity variation $\Delta K = -2.4\%$. By inser-

tion of one or several shim rods one can improve μsub(r) only by 0.5%, reactivity variation constitutes Δ=-1% and the height power peak factor of fuel assemblies located near shim rods increases from 1.05 to 1.08. The neutron flux in the reflector upon D_2O removal from LCS channels increases by 8%. The insertion of a shim rod leads to neutron flux decreasing near the shim rod by 15% and to a certain increase of the neutron flux (by 2-3%) far off. The same flux variations are in experimental channels.

31884 **(ITEF—63(1985)) Calculation of burnable poison in a cyclindrical cell of the TVR-M reactor fuel assembly.** Mikhajlov, V.M.; Myrtsymova, L.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 25p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702075.

The possibility of decreasing the reactivity drop in the TVR-M modernized heavy water cooled reactor for the time between fuel reloadings using a burnable absorber is studied. Natural gadolinium is applied as burnable absorber material. It is placed in a form of a rod or a bush in the center of a fuel assembly. Geometry and gadolinium amount ensuring the least devivations in the multiplication factor during the reactor operating cycle are determined. It is shown that the multiplication factor variation for the period between fuel reloadings is to be a minimum one if rods with gadolinium of the greatest size are used. A noticeable effect on the calculation results is exerted by the neutron spectrum hardness value which in a reactor of small dimensions differs from the cell hardness. The spectrum adjustment can be realized by varying a moderator amount in a cell.

31885 **(NUREG/CR—3064-Vol.1) Computational methodology for the Oak Ridge Research Reactor (ORR) and Bulk Shielding Reactor (BSR): cross-section and validation. Volume 1.** Miller, L.F.; Williams, M.L. (Oak Ridge National Lab., TN (USA)). Mar 1986. Contract AC05-84OR21400. 83p. (ORNL/TM—9968-Vol.1). NTIS, PC A05/MF A01 - GPO. File Number TI86008415.

A neutronics library suitable for low-enrichment uranium (LEU) and high-enrichment uranium (HEU) fueled cores for both the Oak Ridge Research Reactor (ORR) and the Bulk Shielding Reactor (BSR) is documented herein. The library is obtained from version V of the Evaluated Nuclear Data File (ENDF/B-V) and contains 223 nuclides weighted over a variety of region-dependent neutron spectra. Self-shielding and zone-weighting effects are incorporated with 227-group calculations for several reactor-core configurations. Libraries are archived for both transport and diffusion theory seven-group calculations. Complete listings of processing details are included so that libraries with different specifications can be easily obtained. Results from validation calculations indicate that the neutronics libraries obtained from this effort are suitable for neutronics computations for the ORR and BSR. 12 refs., 5 figs., 15 tabs.

2207 Plutonium And Isotope Production Reactors

REFER ALSO TO CITATION(S) 31877, 31878

31886 **(DPST—85-1-12) Savannah River Laboratory monthly report.** (Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). Dec 1985. Contract AC09-76SR00001. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010356.

Efforts in the area of nuclear reactors and scientific computations are reported, including: robotics; reactor irradiation of nonend-bonded target slugs; computer link with Los Alamos National Laboratory; L-reactor thermal mitigation; aging of carbon in SRP reactor airborne activity confinement systems; and reactor risk assessment for earthquakes. Activities in chemical processes and environmental technology are reported, including: solids formation in a plutonium product stream; revised safety analysis reporting for F and H-Canyon operations; organic carbon analysis of DWPF samples; applications of Fourier transform infrared spectrometry; water chemistry analyzer for SRP reactors; and study of a biological community in Par Pond. Defense waste and laboratory operations activities include: Pu-238 waste incinerator startup; experimental canister frit blaster; saltstone disposal area design; powder metallurgy core diameter measurement; and a new maintenance shop facility. Nuclear materials planning encompasses decontamination and decommissioning of SRP facilities and a comprehensive compilation of environmental and nuclear safety issues. (LEW)

2208 Propulsion Reactors

REFER ALSO TO CITATION(S) 31507, 31848

2209 Reactor Safety

REFER ALSO TO CITATION(S) 31507, 31607, 31886, 32478, 32479, 32480, 32481, 32483, 32486, 32487, 32488, 32489, 32491, 32492, 32493, 32494, 32495, 32498, 32502, 32503, 32504, 32505, 32507, 32508, 32509, 32630, 32876, 32877

31887 **(AEEW-R—1763) THETIS 80% blocked cluster experiment. Part 1. Description of THETIS rig, the 80% blocked cluster assembly and experimental procedures.** Jowitt, D.; Cooper, C.A.; Pearson, K.G. (UKAEA Atomic Energy Establishment, Winfrith). Sep 1984. 51p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86702054.

Thermal-hydraulics experiments on a model PWR fuel assembly containing severe partial blockage are reported. Four types of experiment covered single phase, forced reflood, gravity reflood and level swell studies. The main features of the THETIS rig are described together with its instrumentation. Test cluster and blockage geometry are described in detail. Problems encountered during the tests are outlined.

31888 **(AEEW-R—1767) THETIS 80% blocked cluster experiment. Part 5. Level swell experiments.** Jowitt, D.; Cooper, C.A.; Pearson, K.G. (UKAEA Atomic Energy Establishment, Winfrith). Sep 1984. 85p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86702055.

Thermal-hydraulics experiments on a model PWR fuel assembly containing severe partial blockage are reported. Swell level experiments are the subject of this report. These were of two types, boil-up and boil-down. Consistent results were obtained for both, covering a range of system pressures from 2 to 40 bar.

31889 **(AEEW-R—1768) THETIS 80% blocked cluster experiment. Part 6. Overview.** Pearson, K.G.; Cooper, C.A.; Jowitt, D. (UKAEA Atomic Energy Establishment, Winfrith). Sep 1984. 22p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702056.

Thermal-hydraulics experiments on a model PWR fuel assembly containing severe partial blockage are reported. Four types of experiment covered single phase, forced reflood, gravity reflood and level swell studies. A summary of the findings of these experiments is given.

31890 **(CEGB-TPRD/B—0651/N85) Choice of cement for the manufacture of concrete to be activated: the potential for reducing the radiological consequences of reactor decommissioning.** Woollam, P.B. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). May 1985. 7p. (DECOM—85/1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702027.

This report presents trace element analyses of some candidate cements which might be used in the manufacture of Sizewell 'B' concrete. It completes a programme of work whose aim was to investigate the potential for reducing the radiological consequences of reactor decommissioning through selection of construction materials for activated components. In particular, consideration has been given to the potential for reducing the concentration of elements known to activate to long lived daughters.

31891 **(CNEN-NE—1.17) Personnel qualification and quality assurance, for nondestructive tests in nuclear installations.** (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). 1985. 17p. (In Portuguese). Centro de Informacoes Nucleares, Rio de Janeiro, Brazil.

The requirements are presented for personnel qualification, as well as the process for quality assurance, related to the activities of nondestructive tests of important safety items in nuclear installations.

31892 **(CNEN-NE—1.18) Preventive conservation in nuclear power plants.** (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). 1985. 12p. (In Portuguese). Centro de Informacoes Nucleares, Rio de Janeiro, Brazil.

The requirements for preventive conservation during the construction and operation of nuclear power plants are presented. This norm is applicable to any work, anybody or any organization which participates in activities related to important safety items, during the construction and operation of nuclear power plants.

31893 **(CONF-860414—4) Dynamics and inherent safety features of small modular high temperature gas-cooled reactors.** Harrington, R.M.; Ball, S.J.; Cleveland, J.C. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 17p. NTIS, PC A02/MF A01 - GPO. File Number TI86007236.

From 6. power plant dynamics, control and testing symposium; Knoxville, TN, USA (14 Apr 1986).

Investigations were made at Oak Ridge National Laboratory to characterize the dynamics and inherent safety features of various modular high temperature gas-cooled reactor (HTGR) designs. This work was sponsored by the US Nuclear Regulatory Commission's HTGR Safety Research program. The US Department of Energy (DOE) and the Gas Cooled Reactor Associates (GCRA) have sponsored studies of several modular HTGR concepts, each having it own unique advantageous economic and inherent safety features. The DOE design team has recently choses a 350-MW(t) annular core with prismatic, graphite matrix fuel for its reference plant. The various safety features of this plant and of the pebble-bed core designs similar to those currently being developed and operated in the Federal Republic of Germany (FRG) are described. A varity of postulated accident sequences involving combinations of loss of forced circulation of the helium primary coolant, loss of primary coolant pressurization, and loss of normal and backup heat sinks were studied and are discussed. Results demonstrate that each concept can withstand an uncontrolled heatup accident without reaching excessive peak fuel temperatures. Comparisons of calculated and measured response for a loss of forced circulation test on the FRG reactor, AVR, are also presented. 10 refs.

31894 (CONF-8510118—, pp 177-186) **Guidelines for earthquake ground motion definition for the Eastern United States.** Gwaltney, R.C.; Aramayo, G.A.; Williams, R.T. (Oak Ridge National Lab., TN). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557. Contract AC05-84OR21400.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Guidelines for the determination of earthquake ground-motion definition for the eastern United States are established in this paper. Both far-field and near-field guidelines are given. The guidelines were based on an extensive review of the current procedures for specifying ground motion in the United States. Both empirical and theoretical procedures were used in establishing the guidelines because of the low seismicity in the eastern United States. Only a few large to great ($M > 7.5$) sized earthquakes have occurred in this region, no evidence of tectonic surface ruptures related to historic or Holocene earthquakes have been found, and no currently active plate boundaries of any kind are known in this region. Very little instrumented data has been gathered in the East. Theoretical procedures are proposed so that in regions of almost no data a reasonable level of seismic ground motion activity can be assumed. The guidelines are to be used to develop the Safe Shutdown Earthquake, SSE. A new procedure for establishing the Operating Basis Earthquake, OBE, is proposed, in particular for the eastern United States. The OBE would be developed using a probabilistic assessment of the geological conditions and the recurrence of seismic events at a site. These guidelines should be useful in development of seismic design requirements for future reactors.

31895 **(CONF-8510166—) Proceedings of the first international information meeting on the TMI-2 accident.** Langer, S.; Young, W.R. (comps.). (EG and G Idaho, Inc., Idaho Falls (USA); USDOE Idaho Operations Office, Idaho Falls). 1985. Contract AC07-76ID01570. 211p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86010354.

From 1. international information meeting on the TMI-2 accident; Washington, DC, USA (21 Oct 1985).

Separate abstracts were prepared for 14 papers in this report. (JDB)

31896 **(EGG-M—28185) Simulation of the preliminary General Electric SP-100 space reactor concept using the ATHENA computer code.** Fletcher, C.D. (EG and G Idaho, Inc., Idaho Falls (USA)). 1986. Contract AC07-76ID01570. 33p. (CONF-860102—5). NTIS, PC A03/MF A01; GPO Dep. File Number DE86005324.

From 3. symposium on space nuclear power systems; Albuquerque, NM, USA (13 Jan 1986).

The capability to perform thermal-hydraulic analyses of a space reactor using the ATHENA computer code is demonstrated. The fast reactor, liquid-lithium coolant loops, and lithium-filled heat pipes of the preliminary General electric SP-100 design were modeled with ATHENA. Two demonstration transient calculations were performed simulating accident conditions. Calculated results are available for display using the Nuclear Plant Analyzer color graphics analysis tool in addition to traditional plots. ATHENA-calculated results appear reasonable, both for steady state full power conditions, and for the two transients. This analysis represents the first known transient thermal-hydraulic simulation using an integral space reactor system model incorporating heat pipes. 6 refs., 17 figs., 1 tab.

31897 **(ENEA-RT-DISP—82-1) Study on safety criteria and systems for next PWRs.** Petrangeli, G. (ENEA, Rome (Italy). Direzione Sicurezza Nucleare e Protezione Sanitaria). Oct 1982. 77p. NTIS (US Sales Only), PC A05. File Number DE86901382.

At this point in time, the starting boundary conditions for the definition of safety criteria for new power reactors are particularly challenging; in fact the general situation is characterized by an evolutionary process still in being since the TMI accident. Besides the additional safety measures deliberated in the various countries immediately after the accident, further requirements continue to be originated with a trend not yet inclined to saturation. The following cases are particularly meaningful examples of such a process: the requirement for a filtered venting system for the Swedish plants; the proposed rules for protection against the effects of a 75% metal-water reaction in the US (hydrogen control systems, structural requirements, qualification of components against hydrogen burning and detonations; the announcement of a rulemaking hearing in the US in order to define requirements in case of severe fuel damage accidents.) 21 refs.

31898 **(ENEA-RT/ING—82-18) Critical flow of subcooled liquid and jet forces.** Celata, G.P.; Cumo, M.; Farello, G.E.; Incalcaterra, P.C. (ENEA, Rome (Italy). Dipartimento Reattori Termini). Jun 1982. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901375.

With reference to loss of coolant accidents in Light Water Reactors, laboratory tests to measure the critical flowrate in subcooled flows and with different geometries of the discharge channel have been performed. A very simple computation procedure for the critical mass flowrate in subcooled conditions is suggested. The agreement between computed and measured values of the critical mass flowrate is very good down to subcoolings of 20°C. The flow characteristics of the unbounded jets have been systematically investigated both externally (photografic measures of the external shapes at various subcoolings) and internally (pressure profiles in radial and axial directions). The presence in the jets characterized by subcooled inlet conditions of a central liquid core gradually evaporating has been outlined.

31899 **(ENEA-RT/ING—82-22) Post dry-out heat transfer in uncovered core accidents.** Annunziato, A.; Cumo, M.; Palazzi, G. (ENEA, Casaccia (Italy). Dipartimento Reattori Termici). Jul 1982. 24p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901379.

An experimental study about post dry-out heat transfer coefficients, level swell, and two phase flow characterization has been performed at Casaccia Center. Critical qualities, wall and bulk temperatures, pressures, mass flow heat flux and inlet temperature has been measured. Post dry-out heat transfer has been investigated with a particular focus on the droplets entrained in the vapor flow. 21 refs., 11 figs.

31900 **(EPRI-NP—4353-SR) Coordination of safety research for the B and W integral system test program.** Sursock, J.P. (ed.). (Electric Power Research Inst., Palo Alto, CA (USA)). Apr 1986. 231p. Research Reports Center Box 50490, Palo Alto, CA 94303.. File Number TI86920258.

This report describes the MIST facility and all the IST projects sponsored by the USNRC and by EPRI. These support projects have been deemed to play an essential role in helping resolve issues raised by MIST scaling compromises. Each support project is described in detail and application of the expected data to resolution of issues is discussed. The combined effort of MIST and seven other support projects will resolve virtually all questions addressed by the IST program. 36 refs., 53 figs.

31901 **(GSF—38/85) Improvement of quantification of somatic radiation risks at low doses. Final report.** Jacobi, W.; Paretzke, H.G.; Henrichs, K.; Hettig, H.; Jacob, P.; Merkle, W.; Messerer, P.; Schindel, F. (Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.); Gesellschaft fuer Strahlen- und Umweltforschung m.b.H. Muenchen, Neuherberg (Germany, F.R.). Inst. fuer Strahlenschutz). Oct 1985. 359p. (In German). (GSF-S—1270). NTIS (US Sales Only), PC A16/MF A01. File Number DE86751730.

In this research contract several selected topics of basic relevancy for assessment models of radiological consequences of hypothetical reactor accidents have been considered. The investigations focussed on the following areas: 1) Age dependent dose conversion factors for members of the public and their variability for radioisotopes of iodine, strontium, and caesium, - improvement of the accuracy of dose calculations for external gamma irradiation from cloud- and ground-shine; 2) analysis of data and models relevant for the assessment of exposure-time-effect relationships for lethal somatic late effects of lung and breast cancer and of leukemia; 3) analysis of various health status indices (e.g. "loss of healthy life span") with respect to their usefulness in addition to incidence, mortality, etc. for the evaluation of the magnitude of a health detriment due to a previous radiation exposure. (orig./HP).

31902 **(INIS-BR—457) Application of fault tree methodology in the risk analysis of complex systems.** Vasconcelos, V. de. (Minas Gerais Univ., Belo Horizonte (Brazil). Escola de Engenharia). 1984. 153p. (In Portuguese). NTIS (US Sales Only), PC A08/MF A01. File Number DE86702050.

This study intends to describe the fault tree methodology and apply it to risk assessment of complex facilities. In the methodology description, it has been attempted to provide all the pertinent basic information, pointing out its more important aspects like, for instance, fault tree construction, evaluation techniques and their use in risk and reliability assessment of a system. In view of their importance, topics like common mode failures, human errors, data bases used in the calculations, and uncertainty evaluation of the results, will be discussed separately, each one in a chapter. For the purpose of applying the methodology, it was necessary to implement computer codes normally used for this kind of analysis. The computer codes PREP, KITT and SAMPLE, written in FORTRAN IV, were chosen, due to their availability and to the fact that they have been used in important studies of the nuclear area, like Wash-1400. With these codes, the probability of occurence of excessive pressure in the main system of the component test loop - CTC, of CDTN, was evaluated.

31903 (INIS-mf—10109, pp 27/1-27/37) **Complex approach to investigation of reactivity change accidents and accidents due to component malfunction with a view to compiling safety documentation.** Jurecka, J.; Mueller, V.; Tinka, I. (Skoda, Plzen, Czechoslovakia. Zavod Energeticke Strojirenstvi; Energoprojekt, Prague, Czechoslovakia). 1984. (In Czech). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The characteristics are defined for inserting reactivity, the distribution of power in the reactor core, the coefficients of reactivity and kinetic parameters. Measures for reducing the hazard of accidents caused by changes in reactivity are classified into three groups: technical and administrative measures, and the system of accident protection. The methodological approach to analyses is described. An analysis is made of failures due to malfunction of components, namely failures caused by partial blocking of coolant flow through the fuel assembly, failures caused by outages of main circulation pumps, failures caused by outages of turbogenerators and failures caused by breakdown of the feed water regime.

31904 (INIS-mf—10109, pp 12/1-12/10) **Dosimetric services and radiation protection during V-1 nuclear power plant operation.** Feik, K. (Atomova Elektraren Bohunice, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

The dose rates of gamma radiation in service areas are in the region of several tenths of μGy/h; in semi-service areas they are higher. A survey is presented of computed and actual activities of certain corrosion and fission products in primary circuit water in the years 1979 to 1984. Personnel exposure was measured and it was found that 85% of personnel show dose equivalents of up to 0.1 mSv. Of the annual collective dose equivalent, 90 to 95% pertain to the period of refuelling. Dose equivalents of personnel are also higher during repairs. Collective dose equivalents for the individual years of the said period are tabulated, broken down according to the type of work and technological equipment.

31905 (INIS-mf—10109, pp 26/1-26/19) **Analysis of failures of V-1 nuclear power plant significant for safety, and lesson for permanently increasing safety.** Suchomel, J.; Kmosena, J. (Vyskumny Ustav Jadrovych Elektrarni, Jaslovske Bohunice, Czechoslovakia; Atomova Elektraren Bohunice, Jaslovske Bohunice, Czechoslovakia). 1984. (In Slovak). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702065. (CONF-8411248—Pt.1).

From Conference on economics, operating reliability and safety of WWER-440 type nuclear power plants; Tatranska Lomnica, Czechoslovakia (20 Nov 1984).

Of the reported failures of the V-1 nuclear power plant, events have been selected which are significant for reactor operating safety. The basic points are given of the safety analysis of the V-1 operation as are criteria for the selection of failures important with regard to the safety of the nuclear power plant. Tabulated are significant events in the operation of the V-1 plant in the years 1980 to 1983 and they are categorized into events of small, medium and high significance. A detailed description is made of events of high significance at the V-1 plant which include complete loss of power supply for own consumption from the network, disturbance of the bolts of steam generator collectors and damaged heads of best control channels. The failures are described as are the alarm signals used and the elimination of the failure and measures taken for eliminating its causes. A brief description is given of events of medium and small safety significance in the V-1 nuclear power plant. Failures of safety significance in nuclear power plants abroad are listed.

31906 **(INIS-mf—10126) 22 July 1985 - Act on third party liability in the field of nuclear energy.** (International Atomic Energy Agency, Vienna (Austria)). 31 Aug 1985. 4p. (In French and Dutch). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702096.

Published in Moniteur Belge.

This Act, which came into force 10 days following its publication, implements in Belgium the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy and the 1963 Brussels Convention, Supplementary to the Paris Convention, as respectively amended by the Protocols of 16 November 1982.

31907 **(INIS-mf—10127) 3 July 1985: Convention signed in Brussels on 31 January 1963, supplementary to the Paris Convention of 29 July 1960 on Third Party Liability in the Field of Nuclear Energy and Act approving the Protocols to amend the Paris Convention and the Brussels Supplementary Convention.** (International Atomic Energy Agency, Vienna (Austria)). 30 Aug 1985. 9p. (In French and Dutch). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702097.

Published in Moniteur Belge.

This Act refers to the Brussels Supplementary Convention approved by Belgium in 1966 and ratified on 20 August 1985 and approves ratification of the Protocols of 16 November 1982 to amend the Paris Convention and the Brussels Supplementary Convention respectively. The Protocols are reproduced in French, Dutch and German.

31908 **(KFK—4002) COSIMA-experiments, a data base for validation of two-phase flow computer codes.** Class, G.; Meyder, R.; Stratmanns, E. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Nukleare Sicherheit). Dec 1985. 204p. (In German). NTIS (US Sales Only), PC A10/MF A01. File Number DE86751751.

The report presents an overview on the large data base generated with COSIMA. The data base is to be used to validate and develop computer codes for two-phase flow. In terms of fuel rod behavior it was found that during blowdown under realistic conditions only small strains are reached. For clad rupture extremely high rod internal pressure is necessary. Additionally important results were found in the behavior of a fuel rod simulator and on the effect of thermocouples attached on the cladding outer surface. Post-test calculations, performed with the codes RELAP and DRUFAN show a good agreement with the experiments. This however can be improved if the phase separation models in the codes would be updated. (orig./HP).

31909 **(NUREG—0675-Suppl.33) Safety Evaluation Report related to the operation of Diablo Canyon Nuclear Power Plant, Units 1 and 2 (Docket Nos. 50-275 and 50-323). Supplement No. 33 .** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). May 1986. 451p. NTIS, PC A20/MF A01 - GPO. File Number TI86901403.

Supplement 33 to the Safety Evaluation Report for the Pacific Gas and Electric Company's Diablo Canyon Nuclear Power Plant, Units 1 and 2 (Docket Nos. 50-275 and 50-323) has been prepared jointly by the Office of Nuclear Reactor Regulation and the Region V Office of the US Nuclear Regulatory Commission. The supplement reports on the status of the staff's investigation, inspection, and evaluation of allegations and concerns that have been identified to the NRC through March 1986. The report includes a complete listing of all allegations and concerns, indicating the status of their resolution. The NRC staff concludes that the technical issues raised in the allegations with regard to the design, construction, and safe operation of Diablo Canyon Units 1 and 2 have been satisfactorily resolved and no further action is required.

31910 **(NUREG—0857-Suppl.10) Safety evaluation report related to the operation of Palo Verde Nuclear Generating Station, Units 1, 2, and 3 (Docket Nos. STN 50-528, 50-529 and 50-530.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). Apr 1986. 30p. NTIS, PC A03/MF A01 - GPO. File Number TI86901308.

Supplement No. 10 to the Safety Evaluation Report for the application by Arizona Public Service Company et al. for licenses to operate the Palo Verde Nuclear Generating Station, Units 1, 2, and 3 (Docket Nos. STN 50-528/529/530), located in Maricopa County, Arizona, has been prepared by the Office of Nuclear Reactor Regulation of the Nuclear Regulatory Commission. The purpose of evaluation supplement is to update the Safety Evaluation Report by providing an evaluation of (1) additional information submitted by the applicant Supplement No. 9 was issued and (2) other matters requiring staff review since Supplement No. 9 was issued, specifically those issues that required resolution before Unit 2 full-power licensing.

31911 **(NUREG—0900-Rev.1) Nuclear power plant severe accident research plan. Revision 1.** Marino, G.P. (ed.). (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Apr 1986. 126p. NTIS, PC A07/MF A01 - GPO. File Number TI86901240.

Subsequent to the Three Mile Island Unit 2 accident, recommendations were made by a number of review committees to consider regulatory changes which would provide better protection of the public from severe accidents. Over the past six years a major research effort has been underway by the NRC to develop an improved understanding of severe accidents and to provide a technical basis to support regulatory decisions. The purpose of this report is to describe current plans for the completion and extension of this research in support of ongoing regulatory actions in this area.

31912 **(NUREG—1038-Suppl.3) Safety Evaluation Report related to the operation of Shearon Harris Nuclear Power Plant, Unit No. 1 (Docket No. STN 50-400). Supplement No. 3.** (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Reactor Regulation). May 1986. 128p. NTIS, PC A07/MF A01 - GPO. File Number TI86901360.

This report, Supplement No. 3 to the Safety Evaluation Report for the application filed by the Carolina Power and Light Company and North Carolina Eastern Municipal Power Agency (the applicants) for a license to operate the Shearon Harris Nuclear Power Plant Unit 1 (Docket No. 50-400), has been prepared by the Office of Nuclear Reactor Regulation of the US Nuclear Regulatory Commission. This supplement reports the status of certain items that had not been resolved at the time of publication of the Safety Evaluation Report and Supplement Nos. 1 and 2.

31913 **(NUREG/CR—1724) Proceedings of the CSNI specialists meeting on nuclear aerosols in reactor safety.** Kress, T.S. (comp.). (Oak Ridge National Lab., TN (USA)). Oct 1980. Contract AC05-84OR21400. 622p. (ORNL/NUREG/TM—404; CSNI—45; CONF-800434—). NTIS, PC A99/MF A01 - GPO. File Number TI86002655.

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Separate abstracts were prepared for 30 papers in this report. (JDB)

31914 (NUREG/CR—1724, pp 1-23) **Aerosol source considerations for LMFBR core disruptive accidents.** Reynolds, A.B.; Kress, T.S. (Univ. of Virginia, Charlottesville; Oak Ridge National Lab., TN). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Factors that influence the radioactive source term in LMFBR Core Disruptive Accidents (CDA) are reviewed. Three groups of radioactive sources - actinides, sodium, and fission products - are discussed. Potential accident scenarios, including energet-

ic and core-melt CDA's, are reviewed. Mechanisms for release and transport of radionuclides and aerosol formation are discussed at various phases of the scenarios, and programs contributing information on these mechanisms are briefly reviewed. Transport of aerosols between cells and aerosol behavior are not included in this review. 65 refs.

31915 (NUREG/CR—1724, pp 46-56) **Approach to the nuclear aerosol source term assessment in an HCDA of LMFBR.** Tachino, T.; Hasegawa, Y.; Sawada, T.; Yamaguchi, K.; Mitsutsuka, N.; Mochizuki, K. (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan; Power Reactor and Nuclear Fuel Development Corp., Tokyo, Japan). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

A calculational model was developed for estimating the amount of fragmented fuel particles released from the closure head of reactor vessel following a fuel coolant interaction in an HCDA of LMFBR. Sample calculations were performed to determine the relative importance of the various complex physical processes involved in this phenomena. The followings became clear through this investigation: (1) the dimension, shape of bubbles and the contents of noncondensable gas have much influence on the vapor condensation rate; (2) the effect of the mass of the smallest diameter particles is predominant among others for aerosol release. In order to verify the behavior of bubbles, experimental studies are under way. Underwater experiments have been completed and the changes in the shape and velocity of the bubbles rising in a pool were investigated. A small-scale sodium test will be started in the near future.

31916 (NUREG/CR—1724, pp 84-94) **Aerosol release from a hot sodium pool and behavior in sodium vapor atmosphere.** Sauter, H.; Schuetz, W. (Laboratory for Aerosol Physics and Filter Technology, Karlsruhe, Germany). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

For source term assessment, it is necessary to study the sodium retention capability for fuel and fission products, the release rate, the release mechanism, sodium evaporation into an inert gas atmosphere, aerosol formation and properties, and the aerosol behavior in the containment atmosphere. Experiments on these subjects are carried out in the KfK-NALA program, mainly related to the German SNR-300 core catcher problem. Results from small-scale experiments with 100 g Na (NALA I) and from technical scale experiments with 1 kg Na in a heated 2.2 m^3 vessel (NALA II) are presented. UO_2, Cs, NaJ and SrO were used as contamination substances. In case of the NALA I experiments, the released aerosols were transported by an inert carrier gas (forced convection) into cold traps and filters, either at isothermal conditions or with an open vessel in a glovebox. Besides the determination of retention factors, special emphasis was placed on the understanding of the release mechanisms. In the present paper, we focus on the UO_2 particle behavior (pool surface enrichment, size distribution in the surface layer and in the released sodium). The NALA II experiments were carried out with a 400°C to 700°C sodium pool evaporating at natural convection into an 130°C argon atmosphere. First results on uranium, iodine and strontium retention factors are presented, as well as the time behavior of the sodium aerosol mass concentration and the particle size. The mass concentration is compared to PARDISEKO code predictions. Finally, our results on the sodium evaporation rate are given and compared to the sodium vapor pressure.

31917 (NUREG/CR—1724, pp 95-115) **Physical rate processes in confined aerosols.** Stoeber, W.; Zebel, G. (Fraunhofer-Institut fuer Toxikologie und Aerosolforschung, Muenster, Germany). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Radioactive aerosols may come into existence as a result of a severe nuclear reactor accident. To assess the radiation hazard and to develop aerosol suppression systems, a detailed knowledge of the physical rate processes of a confined nuclear aerosol is necessary. For this reason, a theoretical model of the behavior is needed. The physical properties of the aerosol are mainly changed by Brownian and gravitational coagulation, sedimentation, diffusion and thermophoresis. There are still some open questions with regard to the influence of turbulent flow in the reactor containment and the condensation of different materials on the aerosol particles. The nonsphericity of the coagulate particles has to be taken into account by modifying the mobility and the collision cross-section of the aggregates. For the evaluation of the plate-out mechanisms by diffusion and thermophoresis, assumptions about the boundary layer thickness have to be made. The mathematical equations of these physical processes are given and their expected influence on the size and mass distribution as well as on the aerosol decay is discussed. 44 refs.

31918 (NUREG/CR—1724, pp 116-128) **Gravitational collision efficiency of LMFBR aerosols.** Tuttle, R.F.; Loyalka, S.K. (Univ. of Missouri, Columbia). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

The development of an approach to obtain gravitational collision efficiencies for non-spherical post-HCDA LMFBR aerosols is discussed and the correct formulation of the gravitational collision kernel for non-spherical aerosols is presented. Using mass equivalent diameter as the defining length in the gravitational collision kernel, the aerodynamic shape factor, k, the density correction factor, α, and the gravitational collision shape factor, β, are used to correct the collision kernal for the case of collisions between aerosol agglomerates. A specific case of collisions between agglomerates modelled as oblate spheriods and spherical LMFBR aerosols has shown that the shape factor β needs to be investigated further if the growth in size of LMFBR aerosols due to the gravitational coagulation mechanism is to be modelled accurately. In this context, the HAARM-3 shape factors currently used to make corrections for non-spherical aerosols are briefly reviewed. 14 refs.

31919 (NUREG/CR—1724, pp 129-138) **Determination of sodium fire aerosol process coefficients from FAUNA-experiments.** Cherdron, W.; Jordan, S. (Laboratory for Aerosol Physics and Filter Technology, Karlsruhe, Germany). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

In the containment of the FAUNA facility large sodium fires were performed and the time dependent behavior of the aerosols during and after the fire was investigated. One of the main objectives of three sodium fire experiments was to verify calculations with the aerosol code PARDISEKO IIIb. In dynamic experiments the size of different aged sodium fire aerosols were measured by different methods. 10-30 seconds old aerosols were found to have a mass median diameter of about 0.μm with log-normal distribution. The median aerodynamic diameter and the mass equivalent diameter of aerosols were measured during the fire tests. κ was measured during different time of the test and found to be 1.1 at the beginning of the fire. The course of the sodium mass concentration was recalculated with PARDISEKO for a 2 and a 12 m^2 sodium fire test. The coagulation shape factor f, which takes into account the nonsphericity of particles in the coagulation process, was determined by parameter fitting. The course of the aerosol mass concentration during and after a 2 m^2 and a 12 m^2 sodium fire in the FAUNA containment was recalculated with PARDISEKO. Good agreement with experimental data was in particular found in the long term region.

31920 (NUREG/CR—1724, pp 139-150) **Direct measurement of the coagulation shape factor of aerosol particles.** Rehn, B. (Laboratory for Aerosol Physics and Filter Technology, Karlsruhe, Germany). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

In order to measure the coagulation shape factor of an aerosol, a vertical tube of 10 cm internal diameter and variable length was used. Two sampling nozzles, one at the bottom and one at the top of the tube, allowed to connect aerosol measuring instruments to the tube. A platinum oxide generator was built which could produce more than 10^6 particles/cm^3 in the size range $0.0178\ \mu \leqq d \leqq 0.0316\ \mu$. The carrier gas of constant flow rate passed upwards through the tube. Efforts have been made to avoid turbulent flow and to obtain a rectangular velocity profile across the tube. An electrical aerosol size analyzer was used to measure the size distribution of the test aerosol both at the beginning and at the end of the tube corresponding to aerosol ages between t = 0 and t = 150 sec. Simultaneously, the measured size distribution for t = 0 sec was used as input data for theoretical calculations with the aerosol behavior code PARDISEKO IIIb. The coagulation shape factor was then derived by comparison between the calculated and the measured size distribution of the coagulated aerosol. Due to the small size of the generated platinum oxide particles Fuchs' correction has been taken into account for the calculations, thus leading to coagulation shape factor of about 1.0. Without Fuchs' correction the obtained values are too low, in case in point only about 0.2.

31921 (NUREG/CR—1724, pp 151-161) **Morphology and aerodynamics of sodium oxide aerosol at low relative humidities.** van de Vate, J.F.; van Leeuwen, W.F.; Plomp, A.; Smit, H.C.D. (Netherlands Energy Research Foundation, Petten). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Experiments have been conducted in one of the ECN's aerosol chambers using Exploding Wire produced sodium oxide aerosol under dry air conditions (approximately equal but less than100 ppM H_2O). Electron microscope analysis of particles immediately after sampling revealed the typical appearance of metal oxide smoke particles, viz. aggregates of large numbers of solid primaries. The diameters of the primary particles were distributed lognormally with a geometric median diameter of 0.085 μm and a geometric standard deviation of 1.5. Spiral centrifuge analysis yielded dynamic shape factors κ between 2 and 4 for aggregates of aerodynamic diameters between 0.57 μm and 0.92 μm resp. The relation between κ and the number of primaries per aggregate was found to fit nicely the ECN-model for such aggregates, which model has been validated previously experimentally with aerosols of Fe-oxide, Au, U_3O_8 and Cu-oxide. This model with the Na-oxide primaries input data leads to aerodynamic diameter values of about 1.5 μm for a 10 g.m^{-3} aerosol after 15 minutes of dominant Brownian coagulation. This is in reasonable accordance with some experimental observations. Increased humidity or sampling artefacts will lead to compaction of the fluffy aggregates resulting in an increased aerodynamic diameter of about 4 μm or more. 13 refs.

31922 (NUREG/CR—1724, pp 162-170) **Boundary layer for diffusive aerosol deposition onto walls.** van de Vate, J.F.; ten Brink, H.M. (Netherlands Energy Research Foundation, Petten). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Important incoherence exists in literature on the effective thickness δ of the boundary layer across which aerosol particles are deposited by Brownian concentration diffusion onto walls. Values of 1 μm up to several centimeters are reported. The rate of deposition of particles smaller than 0.1 μm will be greatly influenced by diffusive transport through this boundary layer, the rate of which is inversely proportional to δ. Consequently, a reevaluation of the literature data in the light of new experimental information is worthwhile. New experimental data from ECN on stirred diffusive deposition in the size range from molecular up to 0.3 μm reveals that δ is proportional to D/sup n/ (D = diffusion coefficient of the particles) with n = 0.27. This agrees with Fuchs' theory giving n ≃ 0.25. The conflicting literature data on δ (which are too small as a rule) are discussed. From the obtained relation it can be shown that non-stirred diffusive aerosol deposition is unrealistic. It is concluded that stirred diffusive deposition plays a minor role in removal of the aerosol mass from post accident nuclear atmospheres. 19 refs.

31923 (NUREG/CR—1724, pp 171-180) **Measurements of the condensation of steam on different aerosols under LWR core melt down conditions.** Bunz, H.; Schoeck, W. (Kernforschungszentrum, Karlsruhe, Germany). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Condensation of steam on aerosol particles has been demonstrated to be a very effective mechanism for the natural removal of particulate fission products from the containment atmosphere of an LWR during core meltdown accidents. The exact modeling of this process, however, was not possible to date because of missing data of condensation velocities of steam onto the non-spherical and non-uniform particles that are generated by core melting. In the first phase of the experimental part of the NAUA research program the condensation of steam onto realistic aerosols was investigated. Condensational shape factors were evaluated which make the NAUA calculations agree with the experimental results. These shape factors are different for different aerosol materials. In this article a method is described which - by appropriate definitionn of the particle size with respect to condensation - reduces the condensational shape factor to unity in all cases of LWR accident aerosol behavior calculations.

31924 (NUREG/CR—1724, pp 181-195) **Prediction of the rates of chemical transformation of sodium fire aerosols.** Cooper, D.W. (Harvard School of Public Health, Boston, MA). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Sodium fires resulting from accidental releases of liquid sodium from a liquid metal fast breeder reactor (LMFBR) would produce aerosols consisting of oxides of sodium, which would tend to react with available water vapor and carbon dioxide. The hydroxide aerosol particles thus formed would be particularly corrosive and hazardous, likely exceeding the US industrial hygiene threshold limit value of 2 mg/m^3. Reaction of the hydroxide with carbon dioxide to form the carbonate would make the aerosol substantially less hazardous chemically. We extend the analysis of Clough and Garland to study the rates of transformation of the oxides to hydroxide and the hydroxide to the carbonate, assuming that mass transfer is limiting. The cases studied here are gas-phase transport to solid or liquid particles and the transport within particles which are liquids, solids, or agglomerates. For sodium fire aerosols less than 10 μm in diameter, mass-transfer rates in air are sufficiently fast that the particles should be converted to the carbonate within seconds, except those particles which are solid or have a solid shell (and are larger than 1 μm). Such non-porous particles would be expected only if the aerosol passes through a liquid state during or after agglomeration, due to melting or the absorption of water. 23 refs.

31925 (NUREG/CR—1724, pp 196-220) **Sampling techniques and electrical measurements of nuclear aerosols - counting and sizing by condensation nuclei counter and diffusion batteries.** Madelaine, G.J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

In a first part we examine sampling techniques and we insist on precaution to take to have the most representative sampling of the aerosol to be analyzed. The purpose of the second part of this paper is to review the basic principles of the various electrostatic measurement of aerosols. The latest knowledges about electrostatic measurement and sizing devices are discussed. The third part concerns the utilization of Condensation Nuclei Counter and diffusion batteries for detecting and sizing fine particles. 13 refs., 10 figs.

31926 (NUREG/CR—1724, pp 221-231) **Application of optical methods in nuclear aerosol measurements.** Schoeck, W. (Kernforschungszentrum, Karlsruhe, Germany). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Optical aerosol measurement techniques are used as light scattering devices in nuclear aerosol research. The underlying scattering theory, the Mie theory, is known since 1908. Nevertheless, a practical application of light scattering instruments has only recently become possible. The use of light scattering techniques for particle measurement is manyfold, scattering, absorption and extinction methods can be applied to single particles or particle ensembles. The Mie theory gives excellent agreement with measured data as long as the underlying assumptions are met. The assumptions are that particles are spherical and that their complex refractive index is known. With nuclear aerosols this is true only for liquid sodium or water droplets, in which cases the use of in situ measuring optical particle spectrometers is highly recommended. For nonspherical particles the Mie equations hold only approximately, the degree of the approximation varies with particle size. In these cases optical spectrometers can be recommended after careful calibration. In all cases, however, the advantage of optical techniques is that in situ measurements can be done without influencing the aerosol and with high time resolution. These properties are extremely useful for measuring dynamic aerosol systems, or particles which cannot be sampled without changing their properties. Some commercial and a variety of special laboratory prototype instruments exist capable of measuring particles sizes >0.1 μm in the concentration range up to 10^8 P/cm^3. Photometer type instruments have larger ranges but the interpretation of the meter reading is difficult in most cases. 15 refs.

31927 (NUREG/CR—1724, pp 232-248) **Inertial classification of aerosols for size measurement.** Gieseke, J.A.; Parker, G.W. (Battelle, Columbus Labs., OH; Oak Ridge National Lab., TN). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Major inertial size classification techniques and devices have been reviewed. Principles of operation, advantages and limitations of each technique, precautions to be taken in design and operation of the devices are discussed with respect to their applications to nuclear aerosol analyses. Included in the review are sedimentation chambers, elutriators, cascade impactors, centrifuges and cyclones. Based on the comparison of various techniques, it has been concluded that spiral duct centrifuges and cascade impactors are suitable for measuring the aerosol size distribution for nuclear aerosol applications. It is also emphasized that because of the possible operational problems and the variations in performance resulting from sampling conditions, any inertial aerosol measurement device should be calibrated and evaluated under conditions as close as possible to the experimental conditions expected during their use. 17 refs., 9 figs.

31928 (NUREG/CR—1724, pp 262-271) **Experience on measurement methods for sodium fire aerosols.** Cherdron, W.; Hofmann, C.; Jordan, S. (Kernforschungszentrum, Karlsruhe, Germany). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

In sodium cooled fast breeder reactors sodium fires may occur accidently by leaking pipes. One of the most important effects of sodium fires is the release of large amounts of aerosols. The knowledge of the physical and chemical properties of these aerosols is of great importance for the layout of filter systems, reactor components and for estimating the environmental impact of reactor accidents. During sodium fire tests in the FAUNA containment different devices for measuring the aerosol mass concentration and size distribution were used. A new developed automatically and continuously working sodium aerosol mass concentration analyzer will be explained and its output data compared with data from the other methods. The analyzer was found to be the most reliable and sensitive instrument. During and after sodium fire the particle diameter was measured by an Anderson impactor, an aerosol centrifuge, a light scattering instrument, and by analysis of electron microscope photographs. The experience with these instruments is discussed. The measured data are compared and the errors in the measurements of aerosol size distribution derived. The influence of inaccuracies in mass concentration and particle size measurements on code validation is discussed.

31929 (NUREG/CR—1724, pp 272-277) **Measuring techniques for nuclear aerosol experiments.** Nelson, C.T.; Johnson, R.P. (Rockwell International, Canoga Park, CA). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

The various sampling techniques which are currently in use at Atomics International Division, Energy Systems Group of Rockwell International, to characterize the aerosols produced from sodium fires and the vaporization of UO_2 are discussed as well as the expected capabilities and accuracy of these techniques under test conditions. By using a variety of sampling techniques in which the aerosol concentration, wall plating, and fallout histories are obtained for each test, a mass balance of the released aerosols can be obtained. Examination of the mass balance will usually indicate the validity and accuracy of the data.

31930 (NUREG/CR—1724, pp 302-317) **Comparative instrumental study on the size characteristics of yttrium oxide aggregate aerosols.** Kanapilly, G.M.; Cheng, Y.S.; Gray, R.H.; Yeh, H.C. (Lovelace Biomedical and Environmental Research Inst., Albuquerque, NM). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—). Contract AC04-76EV01013.

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Condensation aerosols formed from supersaturated metal oxide vapors are often highly irregularly-shaped aggregates. These irregularly-shaped aerosols cover a wide spectrum of size ranges and are likely to be important aerosols associated with hypothetical nuclear events in which nuclear materials are vaporized. Instrumental methods commonly used for measuring particle size parameters utilize specific aerosol properties and all instruments have size limitations. This report presents the results of a comparative instrumental size characterization study on small Y_2O_3 aggregate aerosols. The instruments used were (1) a TSI model 3030 electrical aerosol analyzer (EAA), (2) a TSI model 3040 wire mesh diffusion battery (DB), (3) a Stoeber aerosol centrifuge (SAC), and (4) a high resolution transmission electron microscope (TEM). The relative reliabilities of the instruments are discussed. The aerosols used in this study were produced by controlled vapor condensation methods. Radiolabeled aerosols, $^{90}Y_2O_3$ and "monodisperse" aerosols obtained by using an electrostatic classifier were also used. The electrical aerosol analyzer provided somewhat larger geometric standard deviations than the other instruments. The nominal diameters of the electrically classified Y_2O_3 aggregate aerosols were different from those measured by other methods. The sizes measured using the EAA, DB, centrifuge and TEM generally agreed with each other. Stereo electron micrographs revealed that these aggregate aerosols were three-dimensional structures. The dynamic shape factors of these aerosols were about 2. 18 refs.

31931 (NUREG/CR—1724, pp 318-346) **Study of multistages cascade impactors.** Boulaud, D.; Madelaine, G.; Vendel, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

The aim of thiw work is the calibration of the aerosol measurement device used in general experiments. In the first part the calibration of the eight-stages ANDERSEN cascade impactor with monodispersed solid particles (polystyrene latex, fluorescein ammonium salt) will be described. The collection efficiency of the stages in relation to the nature of the different surfaces (glass plates, steel plates, oil-coated or uncoated, glass fiber filter) will be determined. The results obtained with monodispersed aerosols will be compared to those obtained with aerosols generated by sodium fire. The set-

up of an aerosol size distribution from the results collected on a cascade impact implies that each stage is characterized by one size. In fact some of these characteristic sizes depend on the distribution of the aerosol tested. This necessitates an exact knowledge of the interdependance. The definition of the different characteristic diameters (cut-off diameter, mass median diameter, effective drop size) and the calculation methods which make it possible to find the value of these diameters from the collection efficiency curves obtained experimentally are recalled. The Picknett numerical method which allows a direct calculation of the aerosol size distribution is also discussed. Finally, after having determined the different characteristic diameters for the eight-stage ANDERSEN impactor, these various methods for setting up an aerosol size distribution will be compared in order to define their field of use. 13 figs.

31932 (NUREG/CR—1724, pp 347-382) **Winfrith studies related to nuclear aerosols and the fast reactor safety program.** Boyd, J.V.; Holland, T.R.; Nichols, A.L. (AEE, Winfrith, England). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

A laboratory devoted to fast reactor aerosol studies has been established at AEE Winfrith. The prime aim is to develop the necessary practical expertise to understand and evaluate nuclear aerosol data associated with hazardous emissions and clean-up plant. Our preliminary studies have been associated with two major problems involving sodium fires: representative sampling and physical analysis of sodium oxide aerosols; and the determination of the sodium hydroxide-carbonate aerosol conversion rate. 27 refs., 19 figs.

31933 (NUREG/CR—1724, pp 383-395) **Measurement of high concentration DOP aerosols by a laser dust counter.** Kitani, S.; Ikezawa, Y.; Kozuka, M. (Japan Atomic Energy Research Inst., Ibraki-ken; Japan Air Cleaning Association, Tokyo). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Light-scattering technique is widely used in industries to measure the particle size distribution and the particle number concentration of aerosols. The number concentration of aerosol is limited in dilute samples less than 100 particles per cm^3. A laser dust counter was applied to measure DOP aerosols with high concentration and polydispersed particle-size distribution. The results showed that the measurement of particle number concentration can be made to 10^5 particles per cm^3 of the particle size range 0.1 to 0.5 μm. These results were compared with those obtained by electric aerosol size analyzer and cascade impactor.

31934 (NUREG/CR—1724, pp 396-401) **Summary - panel discussion on nuclear aerosol measurements.** van de Vate, J.F. Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

The purpose of the discussion was defined as being the assessment of measuring ranges of acceptable accuracy of the various aerosol measurement methods available for validation of nuclear aerosol codes. Plus or minus 25% was indicated as an acceptable accuracy, provided systematic errors (mainly due to non-representative sampling) do not play an important role. Nuclear aerosols have the following features which to a great extent complicate the measurements. They have high mass and number concentrations changing very fast in the early life. The particle size ranges from a few 0.01 μm at birth up to several 10 μm later on. There can exist extreme conditions of high temperature, reactive materials and condensation. In view of this and the general output of computer codes, the measurement methods can be grouped into three categories - mass concentration measurement, - number concentration measurements, - size measurement.

31935 (NUREG/CR—1724, pp 402-411) **Aspects of the moments method for aerosol calculations.** Vaughan, E.U. (Rockwell International, Canoga Park, CA). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

The basis of the aerosol codes HAA-3 and HAARM is the assumption that the particle-size distribution remains log-normal as long as agglomeration processes remain significant. The three parameters of the distribution (airborne concentration, median particle size, and logarithmic variance) are followed in time by means of rate equations for the distribution moments of orders zero, one, and two. Presented here are improvements in the representation by such equations of the thermophoresis process and of the effects of the decrease in effective particle density with increasing particle size. Explicit analytic consequences of special cases of the equations are also presented, both for use in checking the codes and for the sake of possible added insight into aerosol behavior. 9 refs.

31936 (NUREG/CR—1724, pp 412-424) **Relative importance of various coagulation and removal mechanisms for aerosols in finite containers.** Williams, M.M.R.; Fry, T.M.; Harbison, S.A. (Univ. of London, England; Associated Nuclear Services, Epsom, England; Nuclear Installations Inspectorate, London, England). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

Seven distinct processes of aerosol particle coagulation and removal are studied and assessed quantitatively. These are Brownian coagulation, sedimentation coagulation, laminar and turbulent shear coagulation, turbulent inertial coagulation, diffusion to surfaces and gravitational settling. From the basic kinetic balance equation for the particle volume distribution function, $n(v,t)$, we obtain coupled equations for the aerosol number density and volume fraction. The magnitudes of the removal rates for the seven mechanisms described above are given in a concise form. The results show the dominance of Brownian coagulation at early stages in the aerosol life, with the progressive increase in importance of gravitational settling as the aerosol ages. Other mechanisms, such as turbulent and laminar shear coagulation, are seen to be only of secondary importance, unless some artificial method is introduced to promote their action.

31937 (NUREG/CR—1724, pp 425-445) **Aerosol behavior modeling.** Jordan, H.; Schumacher, P.M.; Gieseke, J.A.; Lee, K.W. (Battelle Columbus Labs., OH). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

This paper addresses the simplifying assumptions of the HAARM-3 solution technique by comparing HAARM-3 with a reference code, QUICK, that minimizes simplifying assumptions at the expense, however, of computer storage space and running time. The accuracy of the QUICK code has been successfully tested against alternate methods. The comparison shows remarkable agreement between the two codes for many accident scenarios of interest. It also shows order of magnitude divergence in some cases. As a possible explanation it is suggested that, in a sense, HAARM-3 represents a first order correction to a monodisperse model and that some divergence of its predictions relative to those of a more accurate model must be expected when particle size distributions are, or become, very disperse. The second part of this paper addresses the assumption of uniform aerosol mixing that is fundamental to most existing nuclear aerosol behavior models. To quantify the significance of this assumption, a computer code, the ZONE code, has been developed at Battelle. This code accounts for spatial inhomogeneities using a cell model approach. Predictions of the ZONE code for severe sodium fire accidents are presented and compared with corresponding predictions using the QUICK code. The comparison shows the generally conservative prediction of complete mixing models during the sodium burn period. Complete mixing is predicted by the ZONE code immediately after the fire ceases and

for the following period, the predictions of the ZONE code coincide with those of QUICK. 13 figs.

31938 (NUREG/CR—1724, pp 446-457) **Development of interpolation formulae for rapid evaluation of the attenuation due to aerosol processes of radioactive release following hypothetical fast reactor accidents.** Underwood, B.Y.; Walker, B.C.; Williams, R.J. (UKAEA Safety and Reliability Directorate, Culcheth, England). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

This study investigates via a parametric survey the essential factors determining the magnitude of the release mitigation to be obtained from aerosol deposition and thereby develops analytical and graphical representations which enable a rapid estimation of these attenuations over a range of source magnitudes, leak rates and containment geometries. The benefits obtained from aerosol deposition are conveniently exhibited by expressing airborne mass concentration and cumulative leaked mass in terms of non-dimensional attenuation factors which relate the quantities arising with deposition to those arising without deposition. Agglomeration is seen to play a crucial role in promoting deposition, and the reduction in release can amount to orders of magnitude on the time scale of a day for accidents involving high initial concentrations of airborne particulate. In the context of source magnitude variation for instantaneous releases the appearance of an envelope decay curve for the airborne mass concentration enables simple representations of airborne mass and leaked mass to be developed. The leaked mass for constant fractional leak rate reaches an asymptotic limit at long times, a limit which varies only weakly with injected mass concentration. With regard to variation in containment size, the domination of deposition processes by gravitational settling results in attenuation factors for a given injected mass concentration - for containments of given height - being virtually independent of the area of walls (and roof). In addition, although the process coefficient for gravitational settling is inversely proportional to height, the net effect of a change in height on the attenuation factors for a given initial concentration is remarkably small where the attenuations are significantly different from unity on the time scale of a day. 12 figs.

31939 (NUREG/CR—1724, pp 458-468) **Influence of the source term parameters on aerosol behavior in core melt down accidents in LWRs.** Bunz, H.; Koyro, M.; Schoeck, W. (Kernforschungszentrum, Karlsruhe, Germany). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

A study dealing with the influence of the different source term parameters is presented for the case of an assumed core melt down accident. Calculations with the NAUA-code were carried out using a variety of different values for the aerosol size parameters as well as for the total release airborne mass over a realistic range. The values of the latter indicate a far greater influence on the aerosol behavior than those of the size parameters. An attempt is made to explain these results in qualitative terms. Whilst assessing the radiological consequences of the accident a number of other parameters were also discovered to be of great importance. 10 figs.

31940 (NUREG/CR—1724, pp 469-479) **Aerosol behavior model validation procedure.** Gieseke, J.A.; Lee, K.W.; Jordan, H. (Battelle Columbus Labs., OH). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

A systematic and logical procedure has been developed for validating computer models that calculate aerosol behavior within LMFBR containments through comparisons with experimental measurements. By defining various dimensionless parameters which represent the importance of one aerosol behavior mechanism relative to another, domains of predominant individual mechanisms and their interactions were determined. Six different aerosol behavior mechanisms were considered including agglomeration due to Brownian diffusion, gravitational settling and turbulence, and depositions due to sedimentation, Brownian diffusion and thermophoresis. Expected accident conditions for full scale reactor designs were then mapped into the formulated domains of mechanism predominance. The results show that the three coagulation mechanisms can be important individually or in combination depending on the assumed accident conditions. Among the three deposition mechanisms considered, Brownian diffusion was found to be of least significance for all geometries and conditions considered. A selected number of existing experiments have been used to illustrate the correspondence of these ranges. In addition to experiments for mechanism validation, several additional experiments are recommended for validating specific assumptions employed in the current models such spatial homogeneity of aerosol concentration within the containment vessel and interaction rates among aerosols formed from different materials. Finally, criteria to be used for assessing agreements between predictions and experiments are suggested. 9 refs.

31941 (NUREG/CR—1724, pp 480-496) **Interpretation of the behavior of aerosols generated by a sodium pool fire.** Fermandjian, J.; Malet, J.C.; Casselman, C.; Duverger de Cuy, G.; Bouland, D.; Madelaine, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France; Commissariat a l'Energie Atomique, Cadarache, France). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

For computer model validation, an experimental program on sodium pool fire tests (sodium mass = 10 kg - combustion area = 0.125 m^2 - initial sodium temperature = 450°C) is underway in a 4.4 m^3 steel vessel (diameter = 1.6 m - height = 2.2 m - wall area/volume = 3.4 m^{-1} - floor area/volume = 0.46 m^{-1}) with aerosol mass concentrations superior to 10 g Na_2O_2/m^3. These tests made it possible to obtain: the mass concentration evolution and the size distribution of the suspended particles, particularly by means of cascade impactors - ANDERSEN, 8 stages - with dilution system; the emission rate of the source particles (fire subdivided into a series of sequences from the reference test (total combustion) : fire of predetermined duration by lid setting on the pan); and the kinetics of the aerosol removal on the vessel floor (0.24 g $Na_2O_2/m^2.s$). The application of the computer models (HAARM 3 and PARDISEKO 3B) to these tests showed an agreement between experiments and calculations (factor less than 5 for the mass concentration) by using adequate values for the adjustable parameters (dynamic shape factor - $1 < \kappa < 1.5$ -, coagulation shape factor - $1 < f < 1.5$ -, efficiency collision for gravitational agglomeration - $0.1 < \epsilon < 0.3$ -, boundary layer thicknesses for brownian diffusion - 0.01 mm < δ/sub D/ < 0.1 mm - and for thermophoresis - 1 mm < δ/sub T/ < 3 mm -, correction factor density - $0.2 < \alpha < 0.6$ -). 17 figs.

31942 (NUREG/CR—1724, pp 531-541) **Analytical studies on uranium oxide, sodium oxide and their mixed aerosols by using ABC-3B.** Mitsutsuka, N.; Obata, H. (Power Reactor and Nuclear Fuel Development Corp., Tokyo, Japan; Century Research Center Corp., Tokyo, Japan). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

The behavior of uranium oxide, sodium oxide and their mixed aerosols was studied using ABC-3B code. The code was partly revised to treat aerosol size distribution more reasonably and to account for shape factors. Comparison of code prediction by using apparent density value of 0.4 to 1.0 g/cm^3 with former JAERI experiment results on uranium oxide aerosol showed better agreement compared with the former calculations by using ABC-2. The best matched result was obtained at 3.42 dynamic shape factor and 1.14 collision shape factor. Sodium oxide aerosols can be predicted tolerably well by using 0.3 g/cm^3 apparent density, as have been reported previously. They are better predicted by using 2.1 dynamic shape factor and 2.3 collision shape factor. Only limited case was studied on mixed aerosols, their shape factors found to be an intermediate value between uranium oxide and sodium oxide values. 12 refs., 9 figs.

31943 (NUREG/CR—1724, pp 559-576) **Sensitivity analysis of aerosol behavior model.** Lee, K.W.; Gieseke, J.A.; Reed, L.D. (Battelle Columbus Labs., OH). Oct 1980. NTIS, PC A99/MF A01 - GPO. File Number TI86002655. (CONF-800434—).

From CSNI specialist meeting on nuclear aerosols in reactor safety; Gatlinburg, TN, USA (15 Apr 1980).

A methodology to perform the sensitivity analysis of a fast running computer code was developed. Based on this methodology, the sensitiveness of various independent input variables and model parameters such as initial aerosol properties and containment geometry to the code output has subsequently been studied using the latest version of the aerosol behavior code, designated HAARM-3. The amount of aerosol leaked from the containment was used as the reference code output. The analysis results showed that (1) leak flow rate, (2) particle collision efficiency, (3) aerosol source duration time, (4) mean particle size, (5) source rate, and (6) particle collision shape factor are those which significantly influence the code output in that order. It is further found that these important variables are directly related to reactor accident conditions implying the importance of accident postulations. Among the model parameters, those which govern the aerosol agglomeration mechanism are also found to be important. However, the input variables and parameters that govern the rate of aerosol deposition on walls do not greatly influence the amount of aerosol leaked. 11 refs.

31944 (NUREG/CR—3262-Vol.1) **COBRA-NC: a thermal-hydraulic code for transient analysis of nuclear reactor components. Equations and constitutive models. Volume 1.** Wheeler, C.L.; Thurgood, M.J.; Guidotti, T.E.; DeBellis, D.E. (Pacific Northwest Labs., Richland, WA (USA)). May 1986. Contract AC06-76RL01830. 153p. (PNL—4710-Vol.1). NTIS, PC A08/MF A01 - GPO. File Number TI86010417.

COBRA-NC is a digital computer program written in FORTRAN IV that simulates the response of nuclear reactor components and systems to thermal-hydraulic transients. The code solves the multicomponent, compressible, three-dimensional, two-fluid, three-field equations for two-phase flow. The three velocity fields are the vapor/gas field, the continuous liquid field, and the liquid drop field. The code has been used to model flow and heat transfer within the reactor core, the reactor vessel, the steam generators, and in the nuclear containment. The conservation equations, equations of state, and physical models that are common to all applications are presented in this volume of the code documentation.

31945 (NUREG/CR—3957) **Reliability assessment and probability based design of reinforced concrete containments and shear walls.** Hwang, H.; Reich, M.; Ellingwood, B.; Shinozuka, M. (Brookhaven National Lab., Upton, NY (USA)). Mar 1986. Contract AC02-76CH00016. 110p. (BNL-NUREG—51956). NTIS, PC A06/MF A01. File Number TI86009169.

This report summarizes work completed under the program entitled, "Probability-Based Load Combinations for Design of Category I Structures." Under this program, the probabilistic models for various static and dynamic loads were formulated. The randomness and uncertainties in material strengths and structural resistance were established. Several limit states of concrete containments and shear walls were identified and analytically formulated. Furthermore, the reliability analysis methods for estimating limit state probabilities were established. These reliability analysis methods can be used to evaluate the safety levels of nuclear structures under various combinations of static and dynamic loads. They can also be used to generate analytically the fragility data for PRA studies. In addition to the development of reliability analysis methods, probability-based design criteria for concrete containments and shear wall structures have also been developed. The proposed design criteria are in the load and resistance factor design (LRFD) format. The load and resistance factors are determined for several limit states and target limit state probabilities. Thus, the proposed design criteria are risk-consistent and have a well-established rationale. 73 refs., 18 figs., 16 tabs.

31946 (NUREG/CR—3970) **TRAC-PF1/MOD1 independent assessment. LOBI intermediate break test B-R1M.** Kmetyk, L.N. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1986. Contract AC04-76DP00789. 88p. (SAND—85-2264). NTIS, PC E04/MF A01. File Number TI86010794.

The TRAC-PR1/MOD1 independent assessment project at Sandia National Laboratories is part of an overall effort funded by the NRC to determine the ability of various system codes to predict the detailed thermal/hydraulic response of LWRs during accident and off-normal conditions. The TRAC code is being assessed at SNLA against test data from various integral and separate effects test facilities. As part of this assessment matrix, two ~25% intermediate break counterpart tests, B-RIM performed at the LOBI facility and S-IB-3 performed at the Semiscale Mod-2A facility, have been analyzed. The LOBI B-RIM results show that no core heatup was measured, and none was calculated; there are some differences between calculated results and data, but generally the agreement is good. Comparison of our LOBI results with corresponding results from our analyses of the counterpart test S-IB-3 show that similarities and differences in most of the major phenomena were correctly predicted. 19 refs., 46 figs.

31947 (NUREG/CR—4027) **TRAC-PF1/MOD 1 independent assessment. Condensation in stratified cocurrent flow.** Byers, R.K. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1986. Contract AC04-76DP00789. 102p. (SAND—84-2161). NTIS, PC A06/MF A01 - GPO. File Number TI86010795.

The USNRC is funding efforts at several laboratories to assess the adequacy of various advanced, best-estimate systems codes for predicting the behavior of LWRs in accident and abnormal conditions. Sandia's participation in this project includes the use of TRAC-PF1/MOD1 to model stratified, horizontal cocurrent flow, for comparison with experimental data produced at Northwestern University. The experiments are very simple, and the results should display the effects of mass, momentum, and energy transfer at the interface, as well as those of wall friction. Analyses were performed for four of the Northwestern experiments, which involved condensing steam/water flow in a rectangular channel. The study showed that the code's timestep control algorithm and criteria for steady-state convergence need attention, and that the interfacial heat transfer model generally overpredicts the rate of phase change for conditions of the experiments. In TRAC, horizontal stratified flow is assumed to occur in a channel of circular cross section; this precludes a simple and detailed quantitative comparison between calculated results and the reported experimental data. However, the qualitative effects of various changes in experimental conditions are well predicted in most cases. A very simple ad hoc modification to the interface treatment, based on boundary layer theory, was able to remove some of the larger discrepancies between the experimental and calculated results. Further improvements could probably result from analysis of the data in a different way from that presented in the experiment report, but this possibility was only briefly examined. 51 figs.

31948 (NUREG/CR—4124-Vol.2) **NDE of stainless steel and on-line leak monitoring of LWRs. Annual report, October 1984-September 1985. Volume 2.** Kupperman, D.S.; Claytor, T.N.; Mathieson, T.; Prine, D.W. (Argonne National Lab., IL (USA)). Feb 1986. Contract W-31-109-ENG-38. 53p. (ANL—86-7-Vol.2). NTIS, PC A04/MF A01 - GPO. File Number TI86009592.

This progress report summarizes work performed by the Argonne National Laboratory and GARD, Inc. (Division of Chamberlain Mfg. Corp.) as subcontractor on NDE of stainless steel and on-line leak monitoring of LWRs during the 12 months from October 1984 to September 1985. 15 refs., 36 figs.

31949 (NUREG/CR—4142) Review of the Millstone 3 Probabilistic Safety Study. Garcia, A.A.; Bernreuter, D.L.; McKone, T.E.; Smith, P.D.; Amico, P.J.; Reed, J.W.; McCann, M.W. Jr.; Davis, P.R.; Apostolakis, G. (Lawrence Livermore National Lab., CA (USA)). Apr 1986. Contract W-7405-ENG-48. 343p. (UCID—20330). NTIS, PC A15/MF A01 - GPO. File Number TI86010436.

Lawrence Livermore National Laboratory (LLNL) has conducted a review of the Millstone Unit 3 (MP 3) Probabilistic Safety Study (PSS) for the Office of Nuclear Reactor Regulation, US Nuclear Regulatory Commission (NRC). This probabilistic safety study was performed by Northeast Utilities (NU) in response to a 1981 request from the NRC. The objective of LLNL's review was to review those aspects of the MP 3 PSS leading to estimates of the plant core damage frequency. LLNL estimated core damage frequency from internal events at MP 3 to be about 1×10^{-4} per year. LLNL reviewed major areas of the PSS, including initiating events, event trees, success criteria, fault trees, human factors, component and operating experience data, and treatment of uncertainty. The review of external events included earthquakes, fires, external and internal flooding, extreme winds, aircraft accidents, hazardous materials, and turbine missiles. The MP 3 PSS treated external events, other than seismic and fire, in a cursory manner. LLNL's seismic review effort was curtailed by the staff because of ongoing seismic analysis revisions by NU.

31950 (NUREG/CR—4353) Assessment of post-critical-heat flux models with Lehigh nonequilibrium data. Webb, S.W.; Chen, J.C. (Lehigh Univ., Bethlehem, PA (USA). Inst. of Thermo-Fluid Engineering and Science). Apr 1986. 51p. NTIS, PC A04/MF A01 - GPO. File Number TI86901160.

Equilibrium and nonequilibrium convective film boiling correlations have been compared with separate-effects data obtained recently at Lehigh University. Predictions from eight models were compared with measured values of heat fluxes, wall superheats, and vapor superheats obtained in the single tube test section. While some of the nonequilibrium models predicted wall heat fluxes with reasonable agreement for specified wall superheats, none of the models gave satisfactory predictions of the nonequilibrium vapor superheats. Most models agreed with experimental measurements for some test conditions, but do not adequately predict the vapor superheat or the wall superheat over the entire range of experimental tests. Further improvements in post-CHF models, taking advantage of the increasing experimental data base, are needed.

31951 (NUREG/CR—4413) Loss of control air at Browns Ferry Unit One: accident sequence analysis. Harrington, R.M.; Hodge, S.A. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 89p. (ORNL/TM—9826). NTIS, PC A05/MF A01 - GPO. File Number TI86009102.

This study describes the predicted response of the Browns Ferry Nuclear Plant to a postulated complete failure of plant control air. The failure of plant control air cascades to include the loss of drywell control air at Units 1 and 2. Nevertheless, this is a benign accident unless compounded by simultaneous failures in the turbine-driven high pressure injection systems. Accident sequence calculations are presented for Loss of Control Air sequences with assumed failure upon demand of the Reactor Core Isolation Cooling (RCIC) and the High Pressure Coolant Injection (HPCI) at Unit 1. Sequences with and without operator action are considered. Results show that the operators can prevent core uncovery if they take action to utilize the Control Rod Drive Hydraulic System as a backup high pressure injection system.

31952 (NUREG/CR—4467) Relative importance of individual elements to reactor accident consequences assuming equal release fractions. Alpert, D.J.; Chanin, D.I.; Ritchie, L.T. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1986. Contract AC04-76DP00789. 34p. (SAND—85-2575). NTIS, PC A03/MF A01 - GPO. File Number TI86010636.

The relative importance to offsite health and economic consequences of the radioactive elements in a nuclear reactor core is examined, assuming an equal fraction of the inventory of each element is released. Studies of reactor accident source terms can use these results to identify the elements that are likely to be the more important contributors to offsite consequences. Radionuclide inventories for a 3412 and a 1518 MW thermal PWR and a 3578 MW BWR were calculated with the SANDIA-ORIGEN coden. Of the 89 elements considered by ORIGEN, only about 25 could be important contributors to offsite consequences. The relative radiological importance of the 25 elements was determinde with the MELCOR Accident Consequence Code System (MACCS). 60 nuclides of the 25 elements were examined using the inventory of a 3412 MW PWR. The relative importance of each element was determined for both early and long-term consequences. A number of elements could be important to early and long term doses if released in sufficiently large quantities. However, to be important for early health effects, an element must be released to the environment before there has been sufficient time for an effective emergency respones. 12 refs.

31953 (NUREG/CR—4483) Reactor pressure vessel failure probability following through-wall cracks due to pressurized thermal shock events. Simonen, F.A.; Garnich, M.R.; Simonen, E.P.; Bian, S.H.; Nomura, K.K.; Anderson, W.E.; Pedersen, L.T. (Pacific Northwest Labs., Richland, WA (USA)). Apr 1986. Contract AC06-76RL01830. 249p. (PNL—5727). NTIS, PC A11/MF A01 - GPO. File Number TI86010328.

A fracture mechanics model was developed at the Pacific Northwest Laboratory (PNL) to predict the behavior of a reactor pressure vessel following a through-wall crack that occurs during a pressurized thermal shock (PTS) event. This study, which contributed to a US Nuclear Regulatory Commission (NRC) program to study PTS risk, was coordinated with the Integrated Pressurized Thermal Shock (IPTS) Program at Oak Ridge National Laboratory (ORNL). The PNL fracture mechanics model uses the critical transients and probabilities of through-wall cracks from the IPTS Program. The PNL model predicts the arrest, reinitiation, and direction of crack growth for a postulated through-wall crack and thereby predicts the mode of vessel failure. A Monte-Carlo type of computer code was written to predict the probabilities of the alternative failure modes. This code treats the fracture mechanics properties of the various welds and plates of a vessel as random variables. Plant-specific calculations were performed for the Oconee-1, Calvert Cliffs-1, and H.B. Robinson-2 reactor pressure vessels for the conditions of postulated transients. The model predicted that 50% or more of the through-wall axial cracks will turn to follow a circumferential weld. The predicted failure mode is a complete circumferential fracture of the vessel, which results in a potential vertically directed missile consisting of the upper head assembly. Missile arrest calculations for the three nuclear plants predict that such vertical missiles, as well as all potential horizontally directed fragmentation type missiles, will be confined to the vessel enclosre cavity. The PNL failure mode model is recommended for use in future evaluations of other plants, to determine the failure modes that are most probable for postulated PTS events.

31954 (NUREG/CR—4488) Venting of noncondensible gas from the upper head of a B and W reactor vessel using hot leg U-bend vent valves. Waterman, M.E.; Kullberg, C.M.; Wheatley, P.D. (EG and G Idaho, Inc., Idaho Falls (USA)). Mar 1986. Contract AC07-76ID01570. 37p. (EGG—2436). NTIS, PC A03/MF A01 - GPO. File Number TI86010581.

This report describes RELAP5/MOD2 thermal-hydraulic analyses of noncondensible gas removal from Babcock and Wilcox (B and W) reactor systems before and during natural circulation conditions following a severe core damage accident. Hot leg U-bend vent valves were modeled as the principal noncondensible venting pathway. The analyses will assist the US Nuclear Regulatory Commission (NRC) in determining whether three B and W plants should receive permanent exemptions from a reactor vessel upper head vent requirement. 24 figs.

31955 **(NUREG/CR—4490-Vol.1) Light-water-reactor safety materials engineering research programs. Quarterly progress report, January-March 1985. Volume 1.** (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 82p. (ANL—85-75-Vol.1). NTIS, PC A05/MF A01 - GPO. File Number TI86010620.

This progress report summarizes work performed by the Materials Science and Technology Division of Argonne National Laboratory during January, February, and March 1985 on water reactor safety problems. The research and development areas covered are Environmentally Assisted Cracking in Light-Water Reactors and Long-Term Embrittlement of Cast Duplex Stainless Steels in Light-Water-Reactor Systems. 42 refs.

31956 **(REG/G—SI-501-4) Draft regulatory guide and value/impact statement: station blackout.** Rubin, A.M. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research). Mar 1986. 16p. Nuclear Regulatory Commission Washington, DC 20555. File Number TI86901122.

This guide describes a method acceptable to the NRC staff for complying with the proposed Commission regulation that would require nuclear power plants to be capable of coping with a station blackout for a specified duration. This guide applies to all commercial light-water-cooled nuclear power plants.

31957 **(SAND—86-0254C) Sandia Pulse Reactor personnel dose reduction program.** Philbin, J.S. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 11p. (CONF-860420—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE86009856.

From Fast burst reactor workshop; Albuquerque, NM, USA (8 Apr 1986).

A personnel dose reduction and facility modernization program has resulted in a new appearance and new methods of operation at the Sandia Pulse Reactor (SPR) Facility. By making improvements in many diverse areas - the facility, facility support systems, the reactor stand, and administrative policies - a significant reduction (60%) in the overall personnel dose has been achieved. New Support systems include a remotely controlled, chain-driven experiment retrieval device and a movable, 1.75-inch thick, lead shadow shield. The shadow shield attenuates the radiation field by factors of 10 or higher at normal positions occupied by personnel performing the tasks.

31958 **(SAND—86-1071C) Containment response and radiological release for a TMLB' accident sequence in a large dry containment.** Gasser, R.D.; Bieniarz, P.P.; Tills, J.L. (Sandia National Labs., Albuquerque, NM (USA); Risk Management Associates, Albuquerque, NM (USA); Tills (Jack) and Associates, Inc., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 16p. (CONF-860507—1). NTIS, PC A02/MF A01 - GPO. File Number TI86010474.

From 3. workshop on integrity of containments for nuclear power plants; Washington, DC, USA (21 May 1986).

An analysis has been performed for the Bellefonte Pressurized Water Reactor (PWR) Unit 1 to determine the containment loading and the radiological releases into the environment from a station blackout accident. A number of issues have been addressed in this analysis, which include the effects of direct heating on containment loading and the effects of fission product heating and natural convection on releases from the primary system. The results indicate that direct heating which involves more than about 50% of the core can fail the Bellefonte containment, but natural convection in the Reactor Coolant System (RCS) may lead to overheating and failure of the primary system piping before core slump, thus, eliminating or mitigating direct heating. Releases from the primary system are significantly increased before vessel breach due to natural circulation and after vessel breach due to reevolution of retained fission products by fission product heating of RCS structures. 11 refs.

31959 **Broadening failure rate distributions in PRA uncertainty analyses.** Martz, H.F. (Los Alamos National Lab., NM). *Risk Analysis;* 4: No. 1, 15-23(1984).

Several recent nuclear power plant probabilistic risk assessments (PRAs) have utilized broadened Reactor Safety Study (RSS) component failure rate population variability curves to compensate for such things as expert overvaluation bias in the estimates upon which the curves are based. A simple two-components of variation empirical Bayes model is proposed for use in estimating the between-expert variability curve in the presence of such biases. Under certain conditions this curve is a population variability curve. Comparisons are made with the existing method. The popular procedure appears to be generally much more conservative than the empirical Bayes method in removing such biases. In one case the broadened curve based on the popular method is more than two orders of magnitude broader than the empirical Bayes curve. In another case it is found that the maximum justifiable degree of broadening of the RSS curve is to increase α from 5% to 12%, which is significantly less than 20% value recommended in the popular approach. 15 references, 1 figure, 5 tables.

31960 **Learning from nuclear accident experience.** Vaurio, J.K. (Argonne National Lab., IL). *Risk Analysis;* 4: No. 2, 103-115(1984).

Statistical procedures are developed to estimate accident occurrence rates from historical event records, to predict future rates and trends, and to estimate the accuracy of the rate estimates and predictions. Maximum likelihood estimation is applied to several learning models, and results are compared to earlier graphical and analytical estimates. The models are based on (1) the cumulative number of operating years, (2) the cumulative number of plants built, and (3) accidents (explicitly), with the accident rate distinctly different before and after an accident. The statistical accuracies of the parameters estimated are obtained in analytical form using the Fisher information matrix. Using data on core damage accidents in electricity producing plants, it is estimated that the probability for a plant to have a serious flaw has decreased from 0.1 to 0.01 during the developmental phase of the nuclear industry. At the same time the equivalent frequency of accidents has decreased from 0.04 per reactor year to 0.0004 per reactor year, partly due to the increasing population of plants. 10 references, 7 figures, 2 tables.

25 ENERGY STORAGE

2501 Magnetic

31961 **(TTKK-SVT—1983/7) Storage of electric energy in superconducting magnets.** Eriksson, J.-T. (Tampere Univ. of Technology (Finland). Electrical Power Engineering). Nov 1983. 35p. Tampere Univ. of Technology (Finland). Electrical Power Engineering.

Energy storage for the utility deals mainly with two kinds of energy, heat and electricity. In the present contribution attention in focused on storage of electric energy. Superconductive magnetic energy storage offers several potential advantages over alternative systems: 1) The installation is small in size, 2) Location is usually possible close to the utility system, 3) Excellent efficiency, 92-95%, 4) 50 ms response to power grid fluctuations, 5) Saves several percentages of fossile fuel by letting rotating units operate at optimal efficiency, 6) Is neither pollutive nor radioactive and 7) Long life time, 30-50 years. However, there are questions that require adequate attention. The cost profile contains several unapproved parts, for example the price of superconducting material for high flux change rates and additional expenditure for spare refrigeration equipment. Emergency close down, i.e. energy dumping in case of quenching, has to be taken into consideration, although the cryostable SC wire combined with a sophisticated control system ensures that such an incident will be very rare.

2506 Thermal

REFER ALSO TO CITATION(S) 32058

31962 **(EPRI-CS—4322) Performance of a capacitive cooling system for dry cooling. Final report.** Kooy, R.J.; Laverman, R.J.; Seale, J.L. (CBI Industries, Inc., Plainfield, IL (USA)). Apr 1986. 69p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920268.

The Capacitive Cooling System at the Advanced Concepts Test (ACT) Dry Cooling Facility was successfully operated for 226 h during two test periods in 1984. The Capacitive Cooling System uses thermally stratified water to regulate the daily heat transfer duty of the ACT base ammonia cycle. The Capacitive Cooling System went through 10 major peak and chill cycles during the 1984 tests, with 111 h of peak operation and 115 h of chill operation. The overall system operation was smooth, with no significant oscillations. The steam flow was split between the water-cooled and ammonia-cooled steam condensers, with no detectable adverse affect on the steam turbine operation. The ammonia compressor operation did not appear to adversely affect the operation of the base ammonia cycle. The lubricating oil was effectively contained within the ammonia compressor package assembly. The Capacitive Cooling System controls correctly regulated the water flow and properly controlled the mode of operation. Hot water was effectively layered over cooler water in a 65 ft. dia. water tank. The dynamic movement and stability of the thermocline in the water tank over a 4 day period was successfully demonstrated. Information on thermocline formation and its static degradation was also obtained. 16 refs., 26 figs., 6 tabs.

31963 **(ORNL—6213) Development of a simulation code for a latent heat thermal energy storage system in a space station.** Solomon, A.D.; Morris, M.D.; Martin, J.; Olszewski, M. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 48p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010070.

A conceptual design of a space station power system based on a Brayton cycle and solar powered has been developed. A key part of such a system is the thermal energy storage module, which is of crucial importance during periods of darkness. We have developed a simulation code for one possible storage configuration. In this report, we describe the considerations entering into the code development, and some results obtained thus far.

31964 **High temperature composite thermal storage systems for industrial applications.** Petri, R.J.; Ong, E.T.; Marianowski, L.G. (Institute of Gas Technology, Chicago, IL). *Energy Technology (Washington, D.C.);* **12**: 556-568(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The Institute of Gas Technology is developing an advanced, thermal energy storage (TES) subsystem which employs composite phase change/material sensible heat media. This medium/subsystem is amenable to high temperature thermal storage applications such as industrial reject/process heat recovery and use of off-peak utility and solar dynamic space power systems. The concept allows for direct contact heat exchange between the latent/sensible storage media and compatible working fluids at potentially significant system performance and cost advantages. An overview of research covers the concept, development and testing of the composite media, media behavior, and industrial applications. 6 references, 6 figures, 2 tables.

2509 Batteries

31965 **(ANL—86-14) Chemical Technology Division annual technical report, 1985.** (Argonne National Lab., IL (USA)). Apr 1986. Contract W-31-109-ENG-38. 187p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86008231.

Highlights of the Chemical Technology (CMT) Division's activities during 1985 are presented. In this period, CMT conducted research and development in areas that include the following: (1) advanced batteries - mainly lithium-alloy/metal sulfide and sodium/sulfur; (2) advanced fuel cells with molten carbonate or solid oxide electrolytes; (3) corrosion-protective coatings for high-strength steel; (4) coal utilization, including the heat and seed recovery technology for coal-fired magnetohydrodynamics plants and the technology for fluidized-bed combustion; (5) methodologies for recovery of energy from municipal waste; (6) nuclear technology related to waste management, the recovery processes for discharged fuel and the uranium blanket in a sodium-cooled fast reactor, and proof of breeding in a light water breeder reactor; and (7) physical chemistry of selected materials in environments simulating those of fission and fusion energy systems. The Division also has a program in basic chemistry research in the areas of catalytic hydrogenation and catalytic oxidation; materials chemistry for associated and ordered solutions at high temperatures; interfacial processes of importance to corrosion science, surface science, and catalysis; the thermochemistry of zeolites and related silicates; and the geochemical processes responsible for trace-element migration within the earth's crust. The Division continued to be the major user of the technical support provided by the Analytical Chemistry Laboratory at ANL.

31966 **(DOE/ER/45220—T1) Interfacial electrochemical transport in batteries employing solid electrolytes. Annual report and continuation proposal.** Ratner, M.A.; Shriver, D.F. (Northwestern Univ., Evanston, IL (USA)). 1986. Contract FG02-85ER45220. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010107.

This research project involves a multi-disciplinary investigation of ionic transport along and through interfaces, both within a solid electrolyte and at the electrode/electrolyte contact. Aim is to gain mechanistic understanding of the processes which produce over potentials and limit mobility at these interfaces, and thereby to suggest design steps for improved-performance of solid-state batteries.

31967 **Aluminim-Air Power Cell: A progress report.** Maimoni, A. (Lawrence Livermore National Laboratory, Livermore, CA). pp 14-20 of Proceedings of the 20th intersociety energy conversion engineering conference. Volume 2. Warrendale, PA; Society of Automotive Engineers, Inc. (1985). (CONF-850808—).

From 20. intersociety energy conversion engineering conference; Miami Beach, FL, USA (18 Aug 1985).

The authors are developing the Aluminum-Air Power Cell as a power source for general purpose electric vehicles. Program developments since the 1983 IECEC meeting and more recent reviews are summarized. Program participants are the Lawrence Livermore National Laboratory (LLNL), Eltech Systems Corporation, Alcan Aluminum Ltd., Case Western Reserve University, and SRI International. Estimates of its energy efficiency, using coal as the primary energy source, indicate it is substantially better than the internal combustion engine using synthetic fuels derived from coal. With improved materials it is likely to approach the over-all energy efficiency of rechargeable battery systems. Three experiments involving a 600-cm^2 wedge cell coupled to a crystallizer and a hydrocyclone are described. Substantial progress has been made in the development of the air cathode and aluminum anode materials. The status of various system components is summarized. Crystallization experiments indicate secondary nucleation of small particles can be controlled by operation of the crystallizer at 80°C and agglomeration of fine particles occurs readily under low shear conditions.

31968 **Thermal design requirements of a 50-kW zinc/redox flow battery for solar electrical energy storage.** Selman, J.R.; Wu, H.; Hollandsworth, R.P. New York, NY; American Institute of Chemical Engineers (1985). 23p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

The conceptual engineering design of a large-scale zinc/redox battery for solar electrical energy storage involves the management of considerable heat flows. This is due to the large heat-of-crystallization of sodium ferrocyanide decahydrate produced during discharge, as well as the usual reversible and irreversible cell-reaction heat effects. A discussion of practical design implications is presented.

31969 **Heat generation in lithium-alloy, iron disulfide, high-temperature batteries.** Gibbard, H.F.; Chen, D.M. New York, NY; American Institute of Chemical Engineers (1985). 18p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC03-76SF00098.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Calorimetric measurements were made of the heat flow from a lithium-aluminum, iron disulfide, molten-electrolyte cell, during isothermal discharge at various currents. The discharge process was endothermic on the upper (FeS_2) voltage plateau and exothermic on the lower (FeS) plateau. Inflections in the rate of heat generation correlated closely with phase changes in the positive electrode predicted by the phase diagram of the lithium-iron-sulfur system.

29 ENERGY PLANNING AND POLICY

31970 **(DOE/EIA—0205(86/1)) Energy Information Directory, April 1986.** (National Energy Information Center, Washington, DC (USA)). Apr 1986. 96p. NTIS, PC A05/MF A01; 1 - GPO; GPO Dep. File Number DE86010272.

The National Energy Information Center (NEIC), as part of its mission, provides energy information and referral assistance to federal, state, and local governments, the academic community, business and industrial organizations, and the general public. The two principal functions related to this task are (1) operating a general access telephone line and (2) responding to energy-related correspondence addressed to the Energy Information Administration (EIA). To assist the NEIC staff, as well as other Department of Energy (DOE) staff, in directing inquiries to the proper office within DOE or other federal agencies, the Energy Information Directory was developed. This directory is a list of many of the government offices that are involved in energy matters. The offices are classified according to their specialities. For the purposes of this publication, each office has been given an alphanumeric identification symbol (A-01, A-02, etc.). The subject index uses these identification symbols instead of page numbers in referring the reader to relevant entries. If you should encounter difficulties in reaching anyone listed in the directory or if you are requesting information from EIA, call the NEIC at (202) 252-8800. The DOE employee locator number is (202) 252-5000. If you encounter a problem in receiving a timely or responsive answer to an inquiry, please contact John E. Daniels, Director, National Energy Information Center, (202) 252-2363. This directory is published semiannually, with each issue superseding the previous issue. The publication is free and can be obtained from NEIC. We welcome your comments on the appropriateness and accuracy of the entries in this publication.

31971 **(DOE/S—0010(85)) Secretary of Energy annual report to Congress.** (USDOE Office of the Secretary, Washington, DC). Dec 1985. 231p. NTIS, PC A11/MF A01; GPO Dep. File Number DE86009652.

Activities of all elements of the Department are included except independent Federal Energy Regulatory Commission, which issues its own annual report. This report is supplemented by four annexes: The Eight Report to Congress: Comprehensive Program and Plan for Federal Energy Education, Extension, and Information Activities (published January 1985 by the Assistant Secretary, Conservation and Renewable Energy, US Department of Energy); Sixth Annual Report to Congress on the Automotive Technology Development Program (published September 14, 1984, by the Office of Vehicle and Engine Research, Assistant Secretary for Conservation and Renewable Energy, US Department of Energy); Sixth Annual Report to Congress and the Secretary of Energy on the Nationwide Energy Extension Service Program, by the National Energy Extension Service Advisory Board (published June 1985 by the Office of State and Local Assistance Programs, Assistant Secretary for Conservation and Renewable Energy, US Department of Energy); and the Eighth Annual Report to Congress: Electric and Hybrid Vehicles Program (published February 1985 by the Office of Vehicle and Engine Research And Development, Assistant Secretary, Conservation and Renewable Energy, US Department of Energy).

31972 **(DOT-I—85-44) Dedicated funding arrangements for public transit systems. Final report.** Walther, E.S. (North Carolina Agricultural and Technical State Univ., Greensboro (USA). Transportation Inst.). Jun 1985. 109p. US Dept. of Transportation, Technology Sharing Program, Washington, D.C. 20590. File Number TI86901351.

Objective of the present research is to examine the origination of financial support programs for public transit which support six systems in five states. In addition to reviewing the process which led to the structures, the study attempts to extract the common and continuing themes which pervade those processes and isolate them for comment. The systems examined in this study are: Alameda-Contra Costa Transit District (AC Transit), Oakland, CA; Capital Area Transit (CAT), Raleigh, NC; Metropolitan Atlanta Rapid Transit Authority (MARTA), Atlanta, GA; Municipality of Metropolitan Seattle (METRO), Seattle, WA; New Jersey Transit Corporation (NJ Transit), Newark, NJ; and, San Francisco Municipal Railway (MUNI), San Francisco, CA.

31973 **(DOT-I—86-08) Inventory of innovative financing techniques for transportation. Final report.** Johnson, G.T.; Hoel, L.A. (Virginia Univ., Charlottesville (USA)). Apr 1985. 42p. US Dept. of Transportation, Technology Sharing Program, Washington, D.C. 20590. File Number TI86901350.

A number of innovative financing schemes have recently been developed by state and local transportation agencies which focus on recapturing some of the beneficial impacts from stations and rechanneling them into financial support of the transportation system. As traditional subsidies for transportation decrease, these innovative techniques are becoming increasingly important as a means of meeting local transportation needs. The report is a guide to such techniques and is designed to acquaint transportation planners and other local officials with financing approaches which have been employed in other localities, and to provide them with sufficient understanding of such options as to make preliminary value judgements as to the practicality of alternative approaches for their own jurisdictions. The guide is divided into three major components: a typology of value capture approaches for transportation financing, a description of each approach or element within the given typology, and a detailed annotated bibliography.

31974 **(GAO/RCED—86-47FS) Chemical inventory. Environmental Protection Agency's proposed inventory update.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). Dec 1985. 20p. US General Accounting Office Box 6015, Gaithersburg, MD 20877. File Number TI86901163.

Fact Cheet for The Chairman, Subcommittee on Commerce, Transportation and Tourism, Committee on Energy and Commerce, House of Representivies.

GAO was requested to review the Environmental Protection Agency's (EPA's) proposed approach for updating its chemical substance inventory, authorized by the Toxic Substances Control Act (TSCA). It was agreed to limit work to providing information on EPA's rationale for exempting specific categories of chemicals from the inventory update and the views of major federal users of the inventory concerning these exemptions. Briefly, EPA has proposed to exempt four categories of chemicals from the inventory update: polymers, inorganic chemials, microorganisms, and naturally occurring substances. EPA also proposed to exempt manufacturers from reporting on any chemical manufactured in quantities of less than 10,000 pounds annually at an individual production site. According to EPA, these exemptions were proposed in an effort to focus the inventory update on the chemicals for which EPA is most likely to need information. EPA also plans to add an exemption override for the final rule that will require manufacturers to report on certain chemicals that have been of regulatory concern to EPA under TSCA, even if these chemicals fall into one of the exempted categories. The views of directly responsible agency officials were sought during the course of our work and are incorporated as appropriate.

2901 Energy Analysis And Modeling

REFER ALSO TO CITATION(S) 31406

31975 **(BNL—37939) Examination of sharing fractions for prices and quantities.** Meyer, M. (Brookhaven National Lab., Upton, NY (USA)). Feb 1986. Contract AC02-76CH00016. 50p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86009915.

When the Household Model of Energy (HOME) and Commercial Sector Energy Model (CSEM) are run as modules in the Intermediate Future Forecasting System (IFFS), the interfacing variables (prices and consumption of fuels) have to be adjusted to their aggregated regional levels. Both HOME and CSEM operate at a level of 4 Census Regions whereas IFFS uses 10 federal Regions. This makes it necessary to aggregate the prices provided by IFFS to the 4 Census Regions and to disaggregate the sectoral consumption values calculated by HOME and CSEM to the 10 federal Regions. An examination of the historical fractions for consumption levels and prices by fuels and sectors (residential and commercial) was performed to substantiate the assumption that changes of these fractions over time are not significant. This assumption is presently employed in both HOME and CSEM. The fractions which are presently used were calculated for each fuel based on the consumption data for the year 1980. These fractions, once evaluated, are used for sharing both prices and consumption throughout the forecasting period.

31976 **(NP—6752007) Kenya - energy situation 1984.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Nov 1985. 20p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752007.

After some remarks on Kenya's overall energy situation, extensive data are presented on the supply of crude oil, crude oil products, and electric power. Remarks are made on the energy sources coal, coke, solar energy, biogas, wind power, wood and charcoal, and on bilateral cooperation in the field of energy. (UA).

2902 Economics And Sociology

REFER ALSO TO CITATION(S) 31410, 31461, 31997, 32002, 32004, 32014, 32017, 32115

31977 **(Juel-Spez—292) Socio-compatible energy policies. Experts' opinion on behalf of the Federal Government.** Renn, O.; Albrecht, G.; Kotte, U.; Peters, H.P.; Stegelmann, H.U. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Programmgruppe Technik und Gesellschaft). Jan 1985. 242p. (In German). NTIS (US Sales Only), PC A11/MF A01. File Number DE86751728.

Sozialvertraeglichkeit von Energieversorgungssystemen.

The socio-compatibility project comprises three central analytical elements: 1) The arborescent value analysis: Eminent social groups (such as the trade-unions or the ecological institutes) were questioned on their values and criteria applied to evaluate different energy systems. 2) The energy system and scenario impact analysis: Indicators deduced from the arborescent value analysis serve to approximately cover the value dimensions affected by above criteria. 3) Impact analysis weighing executed by a group of arbitrarily chosen citizens. All reflections considered, it is evident that none of the energy policies discussed may claim the title 'socio-compatible'. The individual, i.e. neither scientist nor politician, cannot decide upon the socio-compatibility of one or the other concept. An altogether socially compatible solution accepted and classified as such by different social groups may only crystallize and be set against different options by the political formation of opinion. The study's primary concern lies in furnishing information, i.e. aids for politicians having to decide on energy policies. Above all the study aimed at finding out about reactions, social protest, opposition or approval to be coped with by those who, having the say in political matters, want to speak up for one of the energy policies under public discussion. (orig./HSCH).

31978 **(NP—6752032) Expansion of district heating networks and the effects on the labour market and employment. Final report.** Westphalen, G.; Strauf, H.G.; Grosche, D.; Kempert, M. (Bundesministerium fuer Arbeit und Sozialordnung, Bonn (Germany, F.R.)). Nov 1983. 191p. (In German). NTIS (US Sales Only), PC A09/MF A01. File Number DE86752032.

The advantages of district heating are undisputed: combined with power production or when using so far unused waste heat district heating proves to be a very energy-saving system. Production plant with - expensive - filters a fulfill the requirements of environmental protection. If an expanded district heating network creates jobs, subsidies for district heating are meaningful not only in an environmental sense but also for the labour market. The present book on labour market and employment effects are described with the example of the Free and Hanseatic City of Hamburg and is meant to be a basis for future discussion in order to facilitate the process of weighing the pros and cons of various sources of energy within the concept of integrated energy supply concepts. (orig./UA).

31979 **(PB—86-159027/XAB) Impact of energy prices on small business. Interim report on tasks 1 and 2. Final report.** Lakhani, F. (Energy, Economics and Environmental Research, Fairfax, VA (USA)). 15 Sep 1983. 23p. NTIS, PC A02/MF A01.

Five major criteria are used by the EEE Research in critically reviewing the studies on impact of energy prices on firms and industries. First, do these studies directly relate to small or large firms. Second, is the time period adopted for the study relevant for the recent increases in energy prices. Third, are the industries covered by the studies disaggregated by SIC codes or too aggregated to be meaningful for policy decision making aimed at specific industries. Fourth, do the studies use the state-of-the-arts methodologies for theoretical and empirical estimation of the impact of energy prices on firms within an industry. Fifth, what are the policy implications of the results of the estimated equations.

2903 Environment, Health, And Safety

REFER ALSO TO CITATION(S) 31568, 31607, 31722, 31781, 31974, 32000, 32004, 32478, 32709, 32756, 32761, 32767, 32790, 32844

31980 **(CONF-8603104—1) Cumulative impacts: real or imagined.** Irving, J.S.; Bain, M.B.; Stull, E.A.; Witmer, G.W. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009182.

From Annual meeting of the Idaho Chapter of the American Fisheries Society; Boise, ID, USA (6 Mar 1986).

This review assesses cumulative environmental effects of existing and proposed hydroelectric development on fish and wildlife.

31981 **(DOE/NBB—0076) Effects of energy technology on global CO_2 emissions.** Cheng, H.C.; Steinberg, M.; Beller, M. (Brookhaven National Lab., Upton, NY (USA)). Apr 1986. Contract AC02-76CH00016. 98p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010257.

The increase in atmospheric CO_2, which results primarily from combustion of fossil fuels for energy, may alter the radiative balance on the earth and thus raise the global temperature. This so-called "greenhouse effect" could cause dramatic global climatic and environmental changes. This study explores the potential for more effective use of energy through improvements in energy technology and determines the consequent reduction in future buildup of atmospheric CO_2 (which would mitigate the expected climatic and environmental changes). The study was done from the perspective of the physical sciences rather than the social and political sciences, i.e., it focused on how energy is consumed for a specific energy service rather than on technical tradeoffs such as use of mass transit instead of automobiles. Calculations showed that an overall reduction of 10 petagrams (10^{15} g) of carbon emission (i.e. reduction of carbon emission from 17 petagrams without improvement to 7 petagrams with improvement) could be achieved in 2050 in the technology improvements discussed in this study were implemented.

31982 **(GAO/RCED—86-65-FS) Hazardous waste. Status of private party efforts to clean up hazardous waste sites.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). Dec 1985. 10p. US General Accounting Office, Box 6015, Gaithersburg, MD 20877. File Number TI86901213.

Fact Sheet for The Chairman, Subcommittee on Commerce, Transportation and Tourism, Committee on Energy and Commerce, House of Representatives.

EPA generally uses the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund) to compel parties responsible for the hazardous condi-

tions at the sites to either perform cleanups themselves or reimburse the government for cleaning up the sites. This fact sheet includes information on the number, type, and status of responsible party cleanup activities at sites on the National Priorities List (designed as the nation's worst sites). We obtained the estimated value of settlements reached and the estimated amount spent at these sites from EPA. We verified to the extent possible those responsible party activities performed in EPA Regions I, II and V that are included in our current review of settlement oversight. Appendix I presents summaries of the nature, extent, and values of responsible party activities performed at priority sites. Appendix II provides information on the 73 settlements where the responsible party agreed to begin some phase of work and shows purpose, status, and estimate value of the planned action.

31983 **(GAO/RCED—86-70-FS) Pollution control. Information on chemical industry safety equipment expenditures.** (General Accounting Office, Washington, DC (USA). Resources, Community and Economic Development Div.). Dec 1985. 8p. US General Accounting Office, Box 6015, Gaithersburg, MD 20877; GPO Dep. File Number TI86901214.

Fact Sheet for The Chairman, Subcommittee on Commerce, Transportation, and Tourism Committee on Energy and Commence, House of Representatives.

Recent expenditures by the chemical and allied products industry on safety-related equipment and associated operating and maintenance costs are reported. Information on capital and operating expenditures for pollution control equipment by wastes category for the chemical and allied products industry are given. The Department of Commerce complies data on pollution abatement costs and expenditures on an annual basis. Information for 1977-83 for the chemicals and allied products industry is summarized. Summary data are provided for the United States and several states, including California, Illinois, Louisiana, Missouri, New Jersey, Texas, and West Virginia.

31984 **(IIUG/dp—84-14) Future directions for environmental policy.** O'Riordan, T. (Wissenschaftszentrum Berlin (Germany, F.R.). Internationales Inst. fuer Umwelt und Gesellschaft). 1984. 43p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752019.

Environmentalism is an elusive concept with many meanings. Its changing character is examined together with an analysis of how it is likely to influence public policy across a broad front. The paper also reviews the major environmental issues which OECD countries are likely to face nationally, regionally and globally over the next twenty years and discusses the type of politics that may emerge within the new environmentalism. The overriding global issue will be the tragic interconnection between poverty and environmental damage in the underdeveloped countries. In the developed but de-industrialising economies of the 'north' greatest attention will be placed on devising means for creating jobs and providing satisfying occupations for people forced out of a job or never in employment. Environmental rehabilitation can create jobs, but it will involve the denial of resources otherwise available to create jobs elsewhere. It will therefore be necessary to consider the 'next job effectiveness' of environmental policies. Another policy area that requires new thinking is the management of environmental hazards, notably how to dispose of toxic wastes in a manner acceptable to a majority of people. Finally serious efforts will have to be made, not only to infuse environmental principles within all policy arenas, but also to ensure that departmental responsibilities and budgets are properly linked. The principle that those who exploit environmental resources should subsidise those who use environmental resources frugally and benignly by means of transfer taxes and payments should also become established. (orig.).

31985 **(IIUG/dp—85-1) Anticipatory environmental policy. Impediments and opportunities.** O'Riordan, T. (Wissenschaftszentrum Berlin (Germany, F.R.). Internationales Inst. fuer Umwelt und Gesellschaft). 1985. 29p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86752024.

The purpose of this paper is to: summarise the state of the art in defining anticipatory (or preventative) environmental policy, examine developments in the application of the anticipatory mode to various environmental policy arenas, assess the relative achievements of these developments according to criteria indicated, explain why anticipatory environmental policy is not proving to be so successful as was expected, and to discuss how the concept can be further defined and how the impediments to its successful application can at least partially be overcome. The background theme to this paper is that anticipatory environmental policy has been promoted too far and too quickly. It is not yet a well defined concept, and cannot apply equally in all sectors of environmental action and public policy. It needs to be redefined to recognise political and administrative realities, and it should be presented as a sequence of progressive stages of application. By disaggregating its purpose, by specifying more precisely its function according to particular policy arenas, and by pinpointing its role in actual strategies, anticipatory environmental thinking should have a vital function in future public policy making. (orig.).

31986 **(PB—85-917015/XAB) Hazardous materials accident report - anhydrous hydrogen fluoride release from NATX 9408, Train No. BNEI3Y at Conrail's Receiving Yard, Elkhart, Indiana, February 4, 1985.** (National Transportation Safety Board, Washington, DC (USA). Bureau of Accident Investigation). 27 Nov 1985. 39p. NTIS, PC A03/MF A01.

At 6:30 a.m., on February 4, 1985, an empty placarded railroad tankcar, containing an estimated 800 gallons of anhydrous hydrogen fluoride, a corrosive liquid, was found leaking in the Consolidated Rail Corporation's Elkhart, Indiana Receiving Yard. During the following 4 hours as local emergency response agencies worked to contain the spill, a vapor cloud formed and traveled approximately 2 1/2 miles affecting nearby residential areas northwest of the yard. A total of 1,500 people within a 1.1-square-mile area adjacent to and northwest of the yard were evacuated for 9 hours as an emergency precaution. Local area hospitals treated 75 persons for minor skin and eye irritations. The National Transportation Safety Board determines that the probable cause of the accident was the decision by Burlington Northern to continue in transportation a tankcar reported to be leaking on February 3, 1985, at its Cicero, Illinois railroad yard. The leak in the tankcar resulted from a failure of the tankcar head at a weld undercut made during its construction. Contributing to the extent of the emergency and the unnecessary endangerment of railroad employees and the surrounding communities was the failure of mechanical inspection and supervisory personnel at both the Burlington Northern Railroad Cicero Yard and the Conrail Elkhart Yard to take prompt, appropriate action once notified of the leak.

31987 **(PB—86-158847/XAB) Projected ocean dumping rates for municipal and industrial wastes in the year 2000. Report for 26 March 1984-26 August 1985.** Cura, J.; Menzie, C.; Borchardt, J. (EG and G/Washington Analytical Services Center, Inc., Waltham, MA (USA)). Aug 1985. 110p. NTIS, PC A06/MF A01.

The amounts of coal ash, flue gas desulfurization (FGD) sludge, sewage sludge, industrial waste, and seafood-processing wastes currently ocean dumped were determined, and ocean dumping of these wastes was projected for the year 2000. The projected rates were made using three different scenarios: Scenario I assumed continued ocean dumping only by current permittees, Scenario II assumed some relaxation of ocean dumping regulation, and Scenario III, to provide a maximum estimate, assumed that future ocean-dumping would be based solely on economic considerations. Coal ash and FGD sludge are projected to be the most voluminous waste dumped under Scenarios II and III, and the East coast of the U.S. would produce the greatest amounts to be dumped.

31988 **EIA scoping for aesthetics: hindsight from the Greene County Nuclear Power Plant EIS.** Petrich, C.H. pp 57-92 of Improving impact assessment: increasing the relevance and utilization of scientific and technical information. Hart, S.L.; Enk, G.A.; Hornick, W.F. (eds.). Boulder, CO; Westview Press (1984). Contract W-7405-ENG-26.

The basic issue in scoping for aesthetic analysis is the initial estimation of significance. The Greene County analysis demonstrates an extreme in terms of significance; where aesthetic considerations effectively terminated a multibillion dollar development.

An approach is suggested that can be used when the public and the EIA experts fail to identify an issue as critical. The approach is made up of three fundamental steps. The first is to try to understand what is of special value in the general landscape. The second step is the identification of those features in the landscape that are in need of special protection. The third step is determining how much change the landscape in question can undergo without losing the intrinsic character identified in the first step or endangering the critical elements identified in the second step. 58 references, 4 figures, 1 table.

2904 Natural Resources

REFER ALSO TO CITATION(S) 31664

31989 (K/ET—5021) Cooling tower drift study at the Oak Ridge Gaseous Diffusion Plant. Park, S.H. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). 1986. Contract AC05-84OT21400. 31p. (CONF-810545—12). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86009958.

From 3. conference on waste heat management and utilization; Miami, FL, USA (12 May 1981).

The environmental study of cooling towers at the ORGDP was continued in 1978. The first investigation conducted in 1973 provided valuable first hand information on drift from two cooling tower cells at ORGDP; however, the drift percentage of 0.1% measured in that test appeared to be high. The 1978 drift study was planned and performed to more closely define the drift phenomenon of the cooling tower complex. The cooling tower cells were involved in the test with drift and ground deposition measurements being performed simultaneously. The average drift percentage measured in this test was 0.03% with acceptable agreement among the ten cells tested. The downfield deposition measurements of chromium supported the deposition findings of the 1973 study. The results of the 1978 studies are considered more reliable than those obtained in 1973 because of the greater mass of data obtained from a greater number of tested cells. The results also indicated that the sensitive paper method with its large sampling volume provides more reliable source characteristics information than the optical measuring device with a very small sampling volume.

2905 Research, Development, Demonstration, And Commercialization

REFER ALSO TO CITATION(S) 31328, 31419, 31437, 31438, 31439, 31441, 31446, 31450, 31453, 31666

31990 (ETSU-N—3/85) Register of R and D projects in the Department of Energy Programme on Renewable Energy Sources. (UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.). Jun 1985. 218p. H.M. Stationery Office, London, price Pound 7.

A register is given of all the R and D programmes on renewable energy which are or have been funded by the U.K. Department of Energy since 1980. The sectors covered include biofuels, geothermal aquifers, geothermal hot dry rocks, small scale hydroelectricity, active solar space and water heating, passive solar design, tidal energy, wave energy and wind energy. (U.K.).

31991 (ETSU-R—28) Renewable energy R and D programmes. (UKAEA Atomic Energy Research Establishment, Harwell. Energy Technology Div.). Jan 1985. 74p. H.M. Stationery Office, London, price Pound 6.

A report is given on the progress with the research and development programmes funded by the UK Department of Energy on renewable energy sources. The report covers the period to March 1985 and was prepared for the Advisory Council for R and D on fuel and power. As well as giving recent progress, an outline of the immediate programme is also given. The areas covered include biofuels, geothermal aquifers, geothermal hot dry rocks, passive solar design, wave energy and wind energy. (U.K.).

31992 (HNEI—6901192) Hawaii Natural Energy Institute. Annual report, 1985. Amoy, D.; Fox, B. (Hawaii Univ., Honolulu (USA). Hawaii Natural Energy Inst.). Feb 1986. 75p. NTIS, PC A04/MF A01. File Number DE86901192.

HNEI has matured into an academic research unit with strong capabilities in all phases of renewable energy R and D. HNEI seeks to establish research excellence by maximizing the potential of Hawaii's unique natural ocean/solar and geothermal laboratories at the Natural Energy Laboratory of Hawaii and the Puna Research Center; as well as research laboratories at UH-Manoa such as the Renewable Resources Research Laboratory and the Physical Electronics Laboratory. HNEI will also continue - as lead agency or as partner with other interested organizations - to work on windpower applications, energy storage, solar photovoltaics, transportation alternatives, environmental and socio-economic issues, and systems integration. Renewables have the potential to assure Hawaii's, the nation's, and the world's energy future. Much remains to be done to prove that potential and to effect the technological and social changes necessary to replace finite conventional fuels which threaten our environment with nonpolluting, abundant renewables.

31993 (INIS-BR—461) Annual technical report of Nuclear Engineering Institute - Physics Department - 1984. (Instituto de Engenharia Nuclear, Rio de Janeiro (Brazil). Dept. de Fisica). 1984. 90p. (In Portuguese). NTIS (US Sales Only), PC A05/MF A01. File Number DE86702106.

Some short communications about the researches developed in the Physics Department of Nuclear Engineering Institute during 1984 are presented.

31994 (INIS-mf—10108) Nuclear power complex. Research in management and management in research. Drahny, M. (Ceskoslovenska Komise pro Atomovou Energii, Prague). 1984. 214p. (In Czech). NTIS (US Sales Only), PC A10/MF A01. File Number DE86702086.

The current state and trends of development of the nuclear power complex are described on the national scale and within the framework of CMEA. The nuclear power complex is defined as an interbranch system with strong material and information linkages. A detailed analysis is presented of the management system and especially its decision-making stage. The characteristics are described of applied research and of technical and economic research relations. The problems are discussed of research management within a research institute. The management laws are applied to the entire branch and complex and are generalized for international scientific and technical cooperation.

31995 (UJV—7198-V) Progress report '84 [Achievements of the Nuclear Research Institute, 1984]. Havelka, St. (Ustav Jaderneho Vyzkumu CSKAE, Rez (Czechoslovakia)). Jan 1985. 67p. (In Czech). NTIS (US Sales Only), PC A04/MF A01. File Number DE86702107.

The most important achievements are summed up of the Nuclear Research Institute in Rez in 1984. They are as follows: mobile cementation lines for the disposal of liquid radioactive wastes, completion of the basic line for the reprocessing of spent fuel, reconstruction of the semi-hot cell for the production of thallium ^{210}Tl, the dummy experiment on the LR-0 reactor which made it possible to define the effect of neutron dose on the service life of a reactor pressure vessel; research was also carried out related to the nuclear safety of PWR reactors, to reactor physics, technology and materials, the fuel cycle, neutron activation analysis and neutron radiography. In the field of production and services there are research results in the manufacture of radiopharmaceuticals and semiconductor detectors, in standardization and in irradiation, computation and information services. Also mentioned is the fulfillment of the Institute's social programme.

31996 **(ZfK—559) Joint annual report 1984.** Hennig, K. (ed.). (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (German Democratic Republic); Bergakademie Freiberg (German Democratic Republic). Sektion Physik; Friedrich-Schiller-Universitaet, Jena (German Democratic Republic). Sektion Physik; Humboldt-Universitaet, Berlin (German Democratic Republic). Sektion Physik; Karl-Marx-Universitaet, Leipzig (German Democratic Republic). Sektion Physik; Technische Univ., Dresden (German Democratic Republic). Sektion Physik). Jun 1985. 227p. (In German and English). NTIS (US Sales Only), PC A11/MF A01. File Number DE86702207.

An account is given on the activities in nuclear and solid state physics. In the field of relativistic nuclear physics first measurements at the Synchrophasotron of the JINR Dubna are presented. Nuclear reactions with heavy ions have been investigated at the cyclotron U-300 of the JINR. Studies of few-nucleon problems and measurements of fission cross sections at the tandem accelerator at Rossendorf have been continued. High spin states in transition nuclei (A approximately 80) and semimagic nuclei have been studied. Works in nuclear theory comprise heavy ion physics, plasma transitions in hot nuclear matter, antikaon production, hypernuclei and deformed nuclei, the time-dependent Hartree-Fock method, meson exchange, and new aspects of shell models. Various studies in solid state physics are presented, including the following: high-dose implantation in metals and semiconductors, tempering in semiconductor materials, light pulse annealing in Si, neutron diffraction in texture analysis, application of Si in the field of sensor technology.

2906 Nuclear Energy

REFER ALSO TO CITATION(S) 31607, 31609, 31911, 31959, 31960, 31977, 31994, 32742

31997 **(DOE/ER—0269) Health physics/radiation protection enrollments and degrees, 1985.** (Oak Ridge Associated Universities, Inc., TN (USA)). Apr 1986. Contract AC05-76OR00033. 63p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86010056.

The 1985 health physics/radiation protection survey included 64 institutions. Sixty-one institutions reported enrollments and degrees awarded; however, 5 of these programs are officially closed but are allowing enrolled students to complete their degree. Two institutions reported their programs were inactive. One institution's program was suspended, having reported the last degree awarded in 1984. Total enrollments in undergraduate and graduate health physics or radiation protection programs decreased from 1984 by 7%. Undergraduate enrollments decreased by 5% to 381; masters candidates decreased by 16% to 527, and doctoral candidates increased by 20% to 216, in large part a result of new foreign graduate students. Of the known placement, by far the largest group of bachelor's graduates continued for further study (27%). The largest employment category was nuclear utilities that recruited 22% of the new bachelor's, compared to only 15% in 1984. Foreign national enrollment at the undergraduate level changed little from 1984. The number of women enrolled in health physics declined at both the baccalaureate and masters degree levels in 1985. However, the number of women pursuing the Ph.D. degree increased by 6 and remained at 16%. Minority participation in 1985 remained the same low level as in past years with only slight variation, primarily among Hispanic US citizens at the undergraduate level and Asian American or Pacific Islanders who generally declined in participation.

31998 **(EPRI-EM—4519-Vol.1) Advanced commercial survey methods (COMSURV). Volume 1. Demonstration of tailored versus general questionnaires. Final report.** McCarthy, P.M.; Bernstein, H.M. (Applied Management Sciences, Inc., Silver Spring, MD (USA)). Mar 1986. 111p. Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303. File Number TI86920246.

This report discusses the results of a demonstration to assess the effects of questionnaire design on response rates, data quality, and general questionnaire performance in commercial sector surveys. With the cooperation of the Virginia Power Company (VEPCO), the concept of tailoring the questionnaire to specific types of commercial establishments was tested in a survey of food stores and office buildings. Tailoring involves the use of trade-specific language, questions about specialized equipment, and special instructions. One result of this study was the demonstration that it is possible to collect detailed trade-specific information with a tailored mail survey instrument. It was also expected that tailoring would improve both overall response rates and question-specific response rates, but this does not appear to be the case. In fact, the results indicate that tailored questionnaires may decrease overall response rates since misclassified units are less likely to respond. In view of this, some guidelines for the use of tailored survey instruments are presented. This report also contains numerous comparisons of the VEPCO survey results with results from the Nonresidential Building Energy Consumption Survey (NBECS). The comparisons reveal that the mail survey technique did provide estimates which compared reasonably with larger-scale on-site surveys.

31999 **(INIS-mf—10090) Annual report 1984-1985 [of the Department of Atomic Energy, of the Government of India].** (Department of Atomic Energy, Bombay (India)). 1985. 78p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86702206.

Research and Development (R and D) activities of the research establishments of the Department of Atomic Energy (DAE), performance of various production units and public sector undertakings of DAE and progress of various projects underway are reported. The report covers the period of the financial year 1984-1985. The research establishments of DAE are the Bhabha Atomic Research Centre at Bombay and the Reactor Research Centre at Kalpakkam. DAE production units include atomic power stations for electricity generation at Tarapur, Kota and Kalpakkam; heavy water plants around the country and the Nuclear Fuel Complex at Hyderabad. Public sector undertaking of the Department are Indian Rare Earths Ltd., Electronic Corporation of India Ltd., and Uranium Corporation of India Ltd. The Atomic Minerals Division of the Department is mainly engaged in the R and D activities pertaining to exploration, prospecting and development of mineral resources needed for nuclear power programme. The Department's objective is to achieve the target of 10,000 MWe of nuclear power generating capacity by the year 2000. The Department's Nuclear Power Board operates the atomic power stations and is charged with the responsibility of design, construction and commissioning of atomic power projects at Narora and Kakrapar. The Department also financially supports the Tata Institute of Fundamental Research, the Tata Memorial Centre, both at Bombay and the Saha Institute of Nuclear Physics at Calcutta. The R and D activities of these institutions are also described in brief in this report. (M.G.B.).

32000 **(INIS-mf—10125) 17 January 1984 - Act approving the Agreement between the Kingdom of Belgium and the Federal Republic of Germany on mutual assistance in the event of catastrophes or serious accidents, signed in Brussels on 6 November 1980.** (International Atomic Energy Agency, Vienna (Austria)). 3 Apr 1984. 8p. (In French, Dutch and German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702092.

Published in Moniteur Belge.

After ratification by the Federal Republic of Germany of the Agreement on mutual assistance in the event of catastrophes or serious accidents, the Belgian Government in turn ratified the Agreement on 17th January 1984. The instruments of ratification having been duly exchanged on 21st March 1984, the Agreement entered into force on 1st May 1984.

32001 **(NUREG—1160) International cooperation during radiological emergencies. NRC program guidance for the provision of technical advice to foreign counterpart organizations.** Senseney, R. (Nuclear Regulatory Commission, Washington, DC (USA). Office of International Programs). Apr 1986. 28p. NTIS, PC A03/MF A01 - GPO. File Number TI86901307.

This report defines the scope, application, and limits of the technical cooperation the Nuclear Regulatory Commission (NRC) would provide, upon request, to a foreign regulatory agency in a nuclear emergency. It outlines the basis for such cooperation, offers

a model written agreement, and describes recent cases of NRC assistance. It also identifies non-NRC sources of emergency advisory assistance available to foreign organizations.

32002 **Strengthening conventional deterrence in Europe: Proposal for the 1980s.** New York, NY; St. Martin's Press (1983). 260p. St. Martin's Press, 175 Fifth Avenue, New York, NY 10010.

A study by leading military and civilian experts from the US and Europe examining the present defenses of Western Europe in light of Warsaw Pact capabilities. The contributors go on to make specific recommendations for improving conventional forces, arguing that NATO forces can be strengthened at acceptable cost, thereby reducing their current dependence on theater nuclear weapons.

2908 Waste Heat Utilization

REFER ALSO TO CITATION(S) 31434, 31978, 32052, 32073, 32116

32003 **(DOE/CE/26530—T1) Phase 1 feasibility study: district heating and cooling using wastewater effluent and sea water in Olympia, Washington.** (VBB Allen, Salem, OR (USA)). Jan 1986. Contract FG01-85CE26530. 156p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86009594.

The feasibility of district heating and cooling (DHC) using low-temperature hydrothermal sources in conjunction with heat pumps has been assessed on a preliminary basis for downtown Olympia and the Capitol Campus. The conclusion is that DHC can provide thermal energy at approximately 75 to 85% of the lowest competing fuel cost in the community. Three potential hydrothermal sources for DHC were evaluated: treated wastewater effluent from the LOTT plant; surface water from Capitol Lake or Budd Inlet; and waste process water from the Olympia Brewery. LOTT effluent and Budd Inlet sea water were both found to be favorable sources, possessing heat pump output potentials far in excess of the service area's heating or cooling demands. Capitol Lake was found to be an unfavorable source because its maximum potential as a heat pump source falls below the service area's thermal demands. The Olympia Brewery was also eliminated because its waste heat was likewise insufficient to meet winter demands, and it requires a costly transmission pipeline to the service area. However, it should be noted that at some point in the future the Brewery could become a DHC customer if its large demand for conventionally-fueled process heat becomes too costly.

32004 **U.S. cities checking cogeneration potential for district heating, cooling.** *Cogeneration Journal;* **1**: No. 1, vp(Sep 1985).

A recently approved DOE grant program provides the impetus for cities to assess the potential for using district heating and cooling systems in communities and to enlist local bankers, industrial firms, businesses and utilities in the assessment effort. Projected community benefits under locally owned district heating and cooling systems include enhanced urban development potential, increased job opportunities, stability of energy costs, and maintenance of environmental quality. The district heating and cooling systems will take hot water or steam derived from coal, gas or waste energy from factories, from burning trash and deliver it through a network of underground pipes to heat or cool buildings and supply hot water.

2910 Conservation

REFER ALSO TO CITATION(S) 32042, 32067, 32080

32005 **(DOE/IG—0227) Department of Energy's state and local assistance program. Final report.** (USDOE Office of Inspector General, Oak Ridge, TN. Eastern Regional Office). 14 May 1986. 48p. TIC, PO Bx 62, Oak Ridge, TN 37831. File Number TI86010452.

Report to The Secretary.

The DOE organization for managing state and local assistance programs (SLAP) was reviewed to determine if DOE was utilizing its resources economically and efficiently in carrying out these programs. The four components of the SLAP are: The Institutional Conservation Program, The Weatherization Assistance Program, The State Energy Conservation Program, and The Energy Extension Service Program. Improvements were needed in the way the SLAP organization is structured and the manner in which certain grants are made. Certain budget, accounting and financial data changes were also identified which will enable the program to be operated more effectively.

2920 Supply, Demand, And Forecasting

REFER ALSO TO CITATION(S) 31411, 31976, 32026, 32028

32006 **(DOE/EIA—0204(86/02)) EIA publications: new releases. Publications released March-April 1986.** (USDOE Energy Information Administration, Washington, DC). 28 Apr 1986. 34p. NTIS, PC A03/MF A01 - GPO; GPO Dep. File Number DE86009883.

32007 **(NP—6751997) Ivory Coast - energy situation 1984.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Sep 1985. 16p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751997.

The energy situation of Ivory Coast is reviewed on the basis of relevant data. Some remarks on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. (UA).

32008 **(NP—6752008) Madagascar - energy situation 1984.** (Foerderungsgemeinschaft Klima e.V. (FGK), Stuttgart (Germany, F.R.)). Nov 1985. 12p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752008.

Madagascar's overall energy situation is reviewed with a view to domestic and imported energy sources, followed by some remarks on the country's national and international energy policy and external trade. (UA).

32009 **(NP—6752009) Sudan - energy situation 1984.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Nov 1985. 17p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752009.

The energy situation of Sudan is reviewed on the basis of relevant data. Some remarks on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Important figures are presented on external trade and the balance of payments. (UA).

32010 **(NP—6752010) Portugal - energy situation 1984.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Nov 1985. 32p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752010.

The energy situation of Portugal is reviewed on the basis of relevant data. Remarks on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Important figures are presented on external trade and the balance of payments. (UA).

32011 **(NP—6752015) Morocco - energy situation 1984.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Oct 1985. 25p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752015.

BfAI-Marktinformation. Reihe MI-BS.; No. 29.478.85.252.

The energy situation of Morocco is reviewed on the basis of relevant data. Some remarks on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Important figures are presented on external trade and the balance of payments. (UA).

32012 **(NP—6752016) Congo People's Republic - energy situation 1984.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Nov 1985. 16p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752016.

The energy situation of Congo People's Republic is reviewed on the basis of relevant data. Some remarks on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Data are presented on external trade and the balance of payments. (UA).

32013 **(NP—6752017) Colombia - energy situation 1984.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Dec 1985. 16p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752017.

The energy situation of Colombia is reviewed on the basis of relevant data. Remarks on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Important figures are presented on the country's external trade. (UA).

32014 **(NP—6752021) Wheel traces of uncertainty - Shell forecasting of the automobile market development through the year 2000.** (Deutsche Shell A.G., Hamburg (Germany, F.R.)). Sep 1985. 32p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752021.

In September 1985 the latest forecasting of automobile market development reaching into the year 2000 was published by the Deutsche Shell AG. Its main results are as follows: In spite of perceptible marketing cutbacks 1 million vehicles have been registered since June 1983. The near future will possibly see another jump. The number of first registrations is expected to culminate at the end of the eighties. The total of first registrations added to the existing stock of vehicles will also stay on a high level in coming years. In the long run automobile density will continuously be increasing and the stocks of registered vehicles will reach their climax at the turn of the century. The demand for replacement explains the exceptional number of first registrations. Diesel engines will more and more gain in importance. (BR).

32015 **(NP—6752028) Iraq - energy situation 1984/1985.** (Bundesstelle fuer Aussenhandelsinformation, Koeln (Germany, F.R.)). Jan 1986. 25p. (In German). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752028.

The energy situation of Iraq is reviewed on the basis of relevant data. Some remarks on the country's national and international energy policy are followed by an outline of trends in energy sources and electric power generation. Important figures are presented on external trade and the balance of payments. (UA).

32016 **Energy trends in the near term.** Linden, A.H. Jr. (Dept. of Energy, Washington, DC). *Energy Technology (Washington, D.C.);* **12**: 28-33(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Projections for the near-term (i.e., through the first half of 1986) show a period of steady but slow growth in energy consumption and production, with consumption increases in coal and natural gas partially offset by a decline in petroleum demand. The efficiency of the economy, as measured by the energy/gross national product ratio, shows continued improvement. The projections also indicate slightly lower oil imports due to lower demand and an assumed suspension in imports for the strategic petroleum reserve. Base case projections, which assume relatively stable prices, through 1990 forecast most of the increase in total energy consumption for the commercial and industrial sectors. For petroleum, they also reflect a decrease in production and increases in consumption and imports between 1985 and 1990.

32017 **Inter-fuel competition in residential and commercial markets.** Pearson, J.D.; Cohen, B.; Holte, J. (Energy Information Administration, Washington, DC). *Energy Technology (Washington, D.C.);* **12**: 77-85(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

This paper focuses on much of the uncertainty that underlies the base case forecasts of energy consumption. The authors illustrate the uncertainty by examining the effects on energy consumption by sector resulting from alternative gross national product and world oil price assumptions as well as alternative assumptions about the relative growth of energy-intensive industries and energy conservation trends. In each case, they contrast the forecast trends to the historical energy-use trends.

2930 Policy, Legislation, And Regulation

REFER ALSO TO CITATION(S) 31461, 31615, 31616, 31617, 31618, 31778, 32000, 32011, 32012, 32013

2940 Fossil Fuels

REFER ALSO TO CITATION(S) 31326, 31328, 31405, 31406, 31406, 31407, 31408, 31409, 31410, 31419, 31419, 31433, 31435, 31437, 31438, 31439, 31441, 31446, 31450, 31453, 31461, 31778, 32016

32018 **(DOE/EIA—0035(86/01)) Monthly energy review, January 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). 29 Apr 1986. 129p. NTIS, PC A07/MF A01; 1 - GPO; GPO Dep. File Number DE86009889.

US energy production during January 1986 totaled 5.6 quadrillion Btu, a 0.3% decrease compared with the level of production during January 1985. Coal production was up 9.2% and petroleum production increased 0.7%. Natural gas production decreased 6.9%. All other forms of energy production combined were down 7.8% from the level of production during January 1985. US energy consumption in January 1986 totaled 6.9 quadrillion Btu, 5.7% below the level of consumption during January 1985. Natural gas consumption decreased 15.2% and petroleum consumption was down 1.4%. Coal consumption increased 1.6%. Consumption of all other forms of energy combined decreased 7.3% compared with the level in January 1985. Net imports of energy for January 1986 totaled 0.8 quadrillion Btu, 25.9% above the level of imports 1 year earlier. Net imports of petroleum increased 26.5%, while net imports of natural gas decreased 7.1%. Net exports of coal were up to 1.6% compared with the level in January 1985.

32019 **(EUR—9475-FR) EFOM energy model: development of a tool to answer questions of energy supply.** Guilmot, J.F. (Commission of the European Communities, Luxembourg). 1984. 281p. European Community Information Service, 2100 M St., NW, Suite 707, Washington, DC 20057.

Use of the EFOM energy model has indicated several of its weaknesses, including the need to be able to model an energy systems' opportunities of reconversion to coal. The use of coal in industry has therefore been modelled independently of other fuels, and the potential for reconverting equipment in the medium term evaluated. Particular attention has been paid to coal conversion techniques such as underground gasification, surface gasification and liquefaction. Energy savings have been considered in the model, in particular the integration of domestic insulation and industrial use of energy. A case- study of the modifications is concluded.

2950 Hydrogen And Synthetic Fuels

REFER ALSO TO CITATION(S) 32151

2960 Electric Power

REFER ALSO TO CITATION(S) 31791, 32035, 32109, 32111, 32115

32020 **(DOE/EIA—0226(86/02)) Electric Power Monthly, February 1986.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). 7 May 1986. 45p. NTIS, PC A03/MF A01; 1 - GPO; GPO Dep. File Number DE86010332.

During February 1986, net generation by electric utilities in the United States was 192,433 gigawatthours. On a year-to-date basis, net generation at the end of February 1986 was 3.7% lower than for the same period in 1985. In February 1986, coal accounted for 57.7% of all electricity produced, petroleum for 4.9%, gas for 7.8%, hydroelectric power for 12.1%, nuclear power for 17.0%, with the remaining 0.5% from geothermal, wood, wind, waste, and solar. In February 1986, electric utilities consumed 55,049 thousand short tons of coal. Petroleum consumption in February 1986 was 16,077 thousand barrels, while gas consumption was 157,070 million cubic feet. On a year-to-date basis, coal consumption at the end of February 1986 was less than 0.1% lower than for the same period in 1985; petroleum consumption was 5.7% lower than during the same period in 1985; and gas consumption was 20.5% lower.

32021 **(DOE/EIA—0397(85/4Q)) Electric Power Quarterly, October-December 1985.** (USDOE Energy Information Administration, Washington, DC. Office of Coal, Nuclear, Electric and Alternate Fuels). 5 May 1986. 327p. NTIS, PC A15/MF A01; 1 - GPO; GPO Dep. File Number DE86010534.

The Electric Power Quarterly (EPQ) provides information on electric utilities at the plant level. The information concerns the following: cost, quantity, and quality of fossil fuel receipts; net generation; fuel consumption; and fuel stocks. The EPQ contains monthly data and quarterly totals for the reporting quarter. Data collected on Form EIA-759 regarding electric utilities' net generation, fuel consumption, and fuel stocks are presented on a plant-by-plant basis. In addition, quantity, cost, and quality of fossil fuel receipts collected on the Federal Energy Regulatory Commission (FERC) Form 423 are presented on a plant-by-plant basis.

32022 **(EPRI-EM—4511-Vol.1) Financial and strategic planning benefits of fuel cell power plants. Volume 1. Results. Final report.** (Temple, Barker and Sloane, Inc., Lexington, MA (USA)). Apr 1986. 109p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920278.

The study quantifies the results of substituting fuel cells for a portion of a more conventional mix of coal-fired steam units and gas-fired combustion turbines owned by a hypothetical utility operating under six scenarios: a "base case" and five scenarios assuming events not planned for. Each scenario compares a Fuel Cells Case with a Conventional Case. The study discovers financial benefits in the form of lower financing requirements and improved indicators of financial health. In support of this finding, a number of measures are quantified, including external financing, total capitalization, internal funds flow, interest coverage, quality of earnings, and construction work in progress. The study's risk analyses investigate unforeseen circumstances relating to load growth, capital costs of fuel cells and coal plants, and the lead time of coal plants. Under uncertainty, the economic and financial benefits are persistent and in some cases much greater than in the base case. Furthermore, the downside risks are small. Thus, fuel cells' strategic benefits can also contribute to a utility's plans for risk management.

32023 **(EPRI-EM—4511-Vol.2) Financial and strategic planning benefits of fuel cell power plants. Volume 2. Supporting graphical results. Final report.** (Temple, Barker and Sloane, Inc., Lexington, MA (USA)). Apr 1986. 59p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920279.

The fuel cell power plant's small size, modularity, and short lead time offer financial and strategic planning benefits to utilities. Under conditions of economic uncertainty, using fuel cells can reduce the price of electricity and total capitalization, improve financial indicators, and reduce external financing - all at minimal risk.

32024 **(EPRI-EM—4527) Electrotechnology reference guide. Final report.** (Resource Dynamics Corp., McLean, VA (USA)). Apr 1986. 97p. Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303. File Number TI86920277.

Recent growth in the industrial use of electricity has opened a door for utilities seeking to help their industrial customers make the most of electrotechnologies. This guide is a resource for utility representatives to use in analyzing major industrial sectors, defining applicable technologies for each, and identifying opportunities for electricity substitution.

32025 **Look at national and regional electric supply needs.** Herod, J.S.; Skeer, J. (Dept. of Energy, Washington, DC). *Energy Technology (Washington, D.C.);* **12:** 120-130(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

On average, electric power generation has been climbing three-fourths as fast as production of goods and services in the recent economic expansion. Although increased energy prices have provided incentives for conservation for over a decade, growth in electric demand is still coupled with growth in the economy. The three basic viewpoints about how to approach the disincentives to efficient production and consumption of electricity are: (1) let the problem correct itself through reduced inflation and interest rates, increased conservation, and reforms within the existing regulatory framework; (2) increase regionalism in the planning, operation, and regulation of electric supply; and (3) abandon portions of the regulatory framework, through a combination of deregulation and restructuring. There is no consensus as to which approach is appropriate. 7 figures.

2980 Consumption And Utilization

REFER ALSO TO CITATION(S) 31975, 32018, 32075

32026 **(CONF-8510242—1-Rev.) Fuel price projections by end-use sector for Illinois. Revision.** South, D.W.; Macal, C.M.; Bragen, M.J.; McDonald, J.F. (Argonne National Lab., IL (USA)). 1985. Contract W-31-109-ENG-38. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86009193.

From 15. annual meeting of the Illinois Economics Association; Chicago, IL, USA (25 Oct 1985).

This paper illustrates the results of an alternative approach for generating fuel price projections at the regional and state level based on national projections. This approach is flexible, adaptive, straightforward and transparent. Moreover, it employs a systematic method for generating a consistent set of projected energy prices through the use of available data. Conceptually, the method entails linking spatial price trends inherent in historic data with projected patterns in aggregate energy prices. This methodology has been incorporated into a modeling system called AREPS, the Argonne Regional Energy Price Simulator. The remainder of this paper addresses the use of AREPS to produce projections for the State of Illinois.

32027 **(DOE/EIA—0214(84)) State energy data report. Consumption estimates, 1960-1984.** (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). 30 Apr 1986. 473p. NTIS, PC A20/MF A01; 1 - GPO; GPO Dep. File Number DE86010331.

The amount of energy consumed within a State is influenced by such factors as geographic size, population, climate, and the amount and type of industry. The sources of the energy consumed vary by State and natural resources. The proportional use by the residential, commercial, industrial, and transportation end-use sectors also varies. The five States that consumed the most energy in

1984 (35%) were Texas, California, Illinois, Ohio, and New York. The top 10 States accounted for 54% of the national total. Petroleum was the major source of energy for four of the five highest energy consuming States. Only Ohio consumed more coal than petroleum products. Natural gas was the next largest energy source in these States. California consumed more energy produced from renewable energy sources than all other States combined - 94% of the estimated US total. The industrial sector was the leading energy-consuming sector in three of the top five States: Texas, Ohio, and Illinois. Transportation accounted for the largest portion of energy consumption in California and New York. When the five States are grouped together, the industrial sector is estimated to have accounted for 39% of the total energy consumed; the transportation sector, 26%; the residential sector, 18%; and the commercial sector, 16%.

32028 **(DOE/EIA—0384(85)) Annual Energy Review, 1985.** (USDOE Energy Information Administration, Washington, DC. Office of Energy Markets and End Use). 7 May 1986. 283p. NTIS, PC A13/MF A01; 1 - GPO; GPO Dep. File Number DE86010432.

Energy production in the United States in 1985 totaled 64.7 quadrillion British thermal units (Btu), 1.7% below 1984. Coal and natural gas accounted for all of the decline. Coal production fell 1.7% to 19.4 quadrillion Btu, and natural gas production was down 5.8% to 16.9 quadrillion Btu. In contrast, nuclear power generation rose 17%. Crude oil production also increased, although by only 0.1%. US energy consumption in 1985 remained virtually the same. US economic growth slowed to 2.3% but, total energy consumption per dollar of GNP fell 2.5%. Petroleum net imports fell 1.0 quadrillion Btu (10.1%) and coal net exports rose 0.3 quadrillion Btu (12.8%). Petroleum imports averaged 5 million barrels per day. About one-third of this total came from Canada and Mexico. Imports from Arab members of OPEC declined to 0.5 million barrels per day in comparison to 0.8 in 1984.

32029 (EPRI-P—4401-SR, pp vp) **Energy use in the service sector: an international perspective.** Jan 1986. NTIS, PC A17/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number DE86006783. (CONF-8503217—). Contract AC03-76SF00098.

From International workshop on electricity use in the service sector; Palo Alto, CA, USA (18 Mar 1985).

The first international comparison of energy use and structure in the service sector of major OECD countries is presented. This sector includes offices, hospitals, schools, stores, and other buildings commonly referred to as commercial buildings. The service sector energy use is separated from other sectors and differences in fuel mix, energy intensity, electricity use, and conservation experience, as well as fundamental differences in the extent and make-up of the building stock and the climate are examined. It is shown that most countries have reduced energy intensity since 1973; all have reduced the share of heating oil and increased the use of electricity, both for space conditioning as well as for other building services. It was also found that energy intensity in US commercial and institutional buildings is among the highest in the OECD, while electricity intensities in Norway, Canada, the US, and Sweden are well above those in other countries.

32030 **(CE-Trans—8138) Decrease in energy consumption in France: a reaction to the present situation or a long term change in trend.** Martin, J.; Chateau, B.; Criqui, P.; Lapillonne, B. Translated from *Revue de l'Energie ;* No. 363, 181-191(Apr 1984). 30p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86901279.

The aim of this article is to continue this study, beginning with a brief analysis of the major energy consumption trends in France since 1950 (first part). A comparison can then be made with trends observed in a number of other major industrialized countries where energy consumption has also decreased in recent years (second part). Two approaches are used to explain the trends observed: the first approach examines the relationship between energy consumption and the main macroeconomic variables (3rd part); the second approach is to study the technical and economic factors governing consumption in residential and transportation sectors.

2990 Unconventional Sources And Power Generation

REFER ALSO TO CITATION(S) 31666, 31696, 31697, 31749, 31764, 31990, 31991, 31992

30 DIRECT ENERGY CONVERSION

3001 Mhd Generators

REFER ALSO TO CITATION(S) 31370, 31965

32031 **(IAE—4038/6) Numerical analysis of possibilities of carbon fuels applied to MHD-generators.** Volkov, Yu.M.; Degtev, Yu.G.; Krikun, V.V.; Khaustov, E.V.; Chernov, Yu.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 21p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701956.

The results of calculations and comparative analysis of energy parameters of some liquid and solid fuels which are of a certain interest in the field of MHD power engineering are presented. The dependences of energy parameters of combustion products of powder carbon fuels on the excess-oxidizer (oxygen), coefficient weight fractions of addition and aluminium in fuel, addition type, chamber pressure, and the degree of expansion of combustion products at the plasma generator output characterize high efficiency of these fuels when using them as working media for MHD-generators of various type and allow one for each concrete problem to choose most optimum composition of fuel. The influence on energy parameters of carbon fuel combustion products of air usage depending on the degree of its heating and oxygen enrichments considered.

3003 Thermoelectric Generators

32032 **(AD-A—164320/4/XAB) Thermal calculation of a thermogenerator at changing temperatures along thermocontact surfaces.** Varshavskiy, G.A.; Rezgol', I.A. (Air Force Systems Command, Wright-Patterson AFB, OH (USA). Foreign Technology Div.). 13 Jan 1986. 16p. (FTD-ID(RS)T—1218-85). NTIS, PC A02/MF A01.

The article finds expressions for the output power of efficiency of a thermoelectric generator and temperature distribution along the heat carrier under the condition that temperatures of the thermocontact surfaces vary due to the cooling and heating of the heat carriers. Simple approximation calculation formulas are given for the particular cases examined. This work is devoted to the finding of analytical bonds, which make it possible to make the calculation of the thermogenerator at changing (as a result of heat transfer) temperatures of the solderings. The obtained expressions can be useful in the preliminary determination of the optimal parameters of the generators (maximal power and efficiency, minimal weight, etc.) and an analysis of processes of regulation.

3005 Fuel Cells

REFER ALSO TO CITATION(S) 31965, 32022, 32023, 32256

32033 **(DOE/MC/20212—2039) Effects of H_2S on molten carbonate fuel cells. Final report.** Remick, R.J. (Institute of Gas Technology, Chicago, IL (USA)). May 1986. Contract AC21-83MC20212. 168p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86010431.

Objective of this program was to identify the poisoning mechanism(s) responsible for performance losses in molten carbonate fuel cells operating on fuels contaminated with ppM levels of H_2S and to develop models and codes to predict cell performance under poisoned conditions. This objective was addressed by focusing out-of-cell and in-cell experiments on single mechanistic issues, followed by incorporation of the results into a model that correlated the performance decline to the contaminant concentration. The importance of this work is that a justifiable specification for gas cleanup for MCFC power plants can now be made and a reason-

ably accurate model now exists which is capable of predicting the impact that upsets in the sulfur cleanup system will have upon cell performance. As the result of this work, it is now known that a complex relationship exists between the level of sulfur contamination and the amount of performance loss that is experienced by a fuel cell operating on contaminated fuel. This loss is dependent upon the total amount of sulfur present in the fuel, the heating value of the fuel, specifically the hydrogen content, the load placed on the fuel cell, and the pressure at which the cell is operating. Therefore, no single set of sulfur cleanup specifications is possible; however, in general, a MCFC system operating on a medium-Btu fuel at atmospheric pressure can tolerate about 1 ppM of total sulfur without suffering any loss in performance and with no adverse long-term effects on materials survivability. Such a system could also handle as much as 5-ppM total sulfur during a temporary upset in the sulfur cleanup system but with a concomitant loss in performance of about 20% provided the upset lasted less than 24 hours.

32034 Oxygen reduction in tetrafluoroethane-1,2-disulfonic acid. Striebel, K.A.; Andricacos, P.C.; Cairns, E.J.; Ross, P.N.; McLarnon, F.R. (Lawrence Berkeley Lab., CA). *Journal of the Electrochemical Society;* **132**: No. 10, 2381-2384(Oct 1985). Contract AC03-76SF00098.

The kinetics of oxygen reduction on platinum in tetrafluoroethane-1,2-disulfonic acid (TFEDSA) and trifluoromethane sulfonic acid (TFMSA) have been studied with the rotating disk electrode technique at pH 1. The resulting Tafel plots coincide within the error of the experiment, indicating similar kinetics in the two electrolytes. The reaction order with respect to oxygen concentration was studied by varying the partial pressure of oxygen above the electrolyte. The rotation-independent currents at 0.90V vs. DHE were used to calculate a reaction order equal to one. A first-order analysis of the rotation-dependent currents was then used to extract kinetic currents at lower potentials. These kinetic currents also exhibited first-order dependence on oxygen concentration. 12 references, 7 figures.

32035 Experience to date: 40kW fuel cell power plant field tests. Moard, D.M. (Southern California Gas Co., Los Angeles). *Energy Technology (Washington, D.C.);* **12**: 1487-1492(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The on-site fuel cell power plant, or gas Powercel, takes the energy of natural gas and converts it into electricity and heat through an electrochemical process. Along with 35 other utility companies in the US and Japan, Southern California Gas Co. (SoCal) tests 40kW fuel cell units in a program sponsored by participating utilities, the Gas Research Institute, DOE and the Department of Defense. SoCal's interest stems from the highly efficient operation coupled with virtually no environmental impact that fuel cells offer. Utilities will evaluate fuel cell technology and determine how it could benefit in an energy service business. The author describes SoCal's study of 10 sites for which technical tests indicate that fuel cells can operate within California's air quality standards, and economic studies show that both an initial and a mature market are attractive. 1 figure.

32036 On-site phosphoric acid fuel cell technology development. King, J.M. *Energy Technology (Washington, D.C.);* **12**: 1493-1498(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

An overview of on-site fuel cell power plant research and development programs covers technical challenges that remain in order to achieve an acceptable capital equipment and operating cost. The major thrusts in capital equipment cost reduction include reducing material costs, increasing the output capability of a given size component, simplifying designs and manufacturing processes, and eliminating components. The thrust in operating cost reduction is to eliminate failures by eliminating components, choosing component approaches with intrinsically lower failure rates, and by devising system approaches which permit continued operation when components fail. The author reviews these efforts and illustrates accomplishments to date in improving overall efficiency. 11 figures.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

REFER ALSO TO CITATION(S) 32005

3201 Buildings

REFER ALSO TO CITATION(S) 31436, 31751, 31754, 31759, 31790, 32095, 32102, 32110, 32131, 32709

32037 (BMFT-FB-T—85-145) Monovalent gas heat pump for all-year use, complex Felix-Klein-Strasse, 8520 Erlangen. Final report. Wurzschmitt, R.; Bub, G.; Wenzl, B. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.); Forschungsstelle fuer Energiewirtschaft, Muenchen (Germany, F.R.)). Dec 1985. 45p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752002.

Construction and operation of a monovalent gas heat pump for space and water heating in a complex of 77 council houses, with a total heated area of about 6,200 m^2 and a heating capacity of 670 kW (DIN 4701). Performance measurements and evaluation during normal operation. Reference data: Monovalent air-to-water gas heat pump for all-year use (tsub(A)=-18°C), performance factor 1.5, radiator heating 70°/40°C, screw compressors, generators for independent electricity supply (evaporation blower). The heating seasonal performance factor of the plant was about 1. The monovalent design caused technical problems and was uneconomical. Problems were encountered in the fields of dimensioning (heat requirements), control of space heating (water volumes and temperatures), the screw compressor (shaft sealing, refrigerant, oil), and the evaporator (thawing processes). At the present state of the art, monovalent air-to-water gas heat pumps cannot compete with modern heating boilers as regards economic efficiency (investment cost, energy cost, operating cost). Bivalent concepts seem to offer advantages, e.g. optimum component design, lower investment costs, and a high seasonal performance factor. (orig.). With 13 refs., 22 figs.

32038 (BMFT-FB-T—85-157) Development of a monovalent resorption heat pump for residential heating. Final report. Engelhard, J. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.); Maschinenfabrik Augsburg-Nuernberg (M.A.N.) A.G., Muenchen (Germany, F.R.). Bereich Neue Technologie). Dec 1985. 69p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752004.

A prototype heat pump was built for a maximum heating capacity of 18 kW, which can be operated with two-stage gas resp. oil burners. The heat pump uses a modified absorption process with an ammonia-water solution. At favourable conditions a heating efficiency of 1.3 is possible. A microprozessor control system enables to optimize the process according to the heat demand. The heat pump can be used monovalent or in combination with a heating boiler. (orig.). Report sequential to BMFT-FB-T--84-047. With 1 tab., 21 figs.

32039 (BMFT-FB-T—85-168) Utilization of soil heat for air conditioning of buildings, as applied in the new theatre of the city of Heilbronn. Final report. Mayer, E.; Laabs, K.D.; Roeber, E. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 91p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE86752013.

Study of the utilization of the heat potential of the soil for cooling (summer) or heating (winter) of air in a THERMODUCT for the supply of air conditioning systems of the theatre of the city of Heilbronn. Assessment of economic aspects in order to determine the amount of energy expected to be saved and the amortization period for the planned THERMODUCT. Cost benefit calculations on the basis of operational data for the built-in THERMODUCT based on climatic data taken over a period of apr. 2 1/2 years and on representative data. Comparison of additional investment with cost reduction through energy savings. Presentation of

results based on knowledge gained in connection with the construction of a THERMODUCT at the theatre of the city of Heilbronn. (orig./HW). With 5 refs., 29 tabs., 14 figs.

32040 **(BMFT-FB-T—85-169) District heating system with heat pump aggregates driven by gas engines or electric motors. Final report.** Dohrn, E. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 30p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752012.

For the supply of a small district heating grid combined gas- and electric operated heats pumps in tandem arrangement were developed. The gas-engine drives an electric asynchronous motor with transmission shaft via a shiftable clutch connected by a shiftable clutch with the heat pump. Surface water from surface wells of an adjoining flood land is the heat source for the heat pumps. In normal operation gas engine generator-heat pumps are utilized during High-Tariff-Time from 06.00 until 22.00 h and heat pumps with electric motors during Low-Tariff-Time. The production of heat is controlled by the heat pumps. In case of deficient power and for reheating during Low-Tariff Time downstream water boilers will be utilized. For peak power supply in the public power distribution grid or in case of insufficient temperature of heat source water only electric power will be generated. The operational data gained during one year show the expected savings of primary energy. By selecting the suitable operation method the plants can well be accomodated to all operating conditions and thus achieve maximum economic efficiency. (orig./HW). With 7 tabs., 7 figs.

32041 **(CERIB-PT—75) Evaluation method for thermal response factors of precast concrete walls.** Dutruel, F. (Centre d'Etudes et de Recherches de l'Industrie du Beton Manufacture (CERIB), 28 - Epernon (France)). Jun 1985. 13p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE86750846.

The role of thermal inertia with respect to comfort and especially summer comfort is well known. Its seems, however, necessary to outline its influence with respect to energy saving, while taking into account the wall construction and particularly the type of insulation. The numerical calculation methods that are currently used are rather complicated and necessitate simplifying hypotheses, which give somewhat differing results. The paper describes the results of the CERIB tests with respect to the response of vertical and horizontal walls in a variable state. These results lead to the development of a new three-dimensional method for housing and facilitate the choice of the most adequate type of concrete products for each type of wall, if one wants to take advantage of thermal inertia.

32042 (CONF-850241—, pp 3-8) **Local employment impact of conservation and renewable energy measures: input/output analysis with a microcomputer.** Rodberg, L.S. (Queen's Univ., Flushing, NY). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A microcomputer program has been developed to compute the local employment impacts of investments in energy conservation and renewable energy or of a change in energy prices. For investment in energy-saving measures, the required inputs include the cost of the measures, the portion of the materials manufactured in the local community, the non-renewable energy saved by the measures, and the rate at which the measures are installed. For energy price shifts, total current expenditures and the expected change in price and consumption are needed. The user is asked to characterize the local economy in terms of local purchase coefficients, the portion of the inputs used by local industries which are purchased from local producers or suppliers. The economic analysis is accomplished by aggregating input/output tables prepared by the Bureau of Labor Statistics into an 8-sector model of the economy and a 3-sector model of the conservation and renewable energy industry. The outputs of the program include estimates of the direct and indirect employment generated in the community, job displacement in the existing energy industry, substitution jobs created (or lost) as dollars are shifted from (or toward) energy consumption, and jobs affected by workers spending their income in the local economy. Direct employment is broken down further by industry and occupational category. The program is written in Microsoft BASIC. Running time is about 1 minute, permitting extensive parametric analysis.

32043 (CONF-850241—, pp 9-12) **Economic optimization of conservation and solar heating systems.** Gery, F.W. (Saint Olaf College, Northfield, MN). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

JOINT.BAS, a program for microcomputers, permits maximum flexibility in determining the effects of alternative energy cost minimization strategies. Effects of combined optimization of conservation and solar heating together are explored. Marginal cost equivalency is the driving force behind the model, applicable to 19 geographic locations in the US. Location specific insolation and heat loss data along with economic parameters are inputs to the model. Load and cost estimation are the outputs.

32044 (CONF-850241—, pp 23-25) **Evaluation of the income required to qualify for an energy efficient home mortgage.** D'Ambra, C.A.; Saiia, C.G. (Resource Planning & Analysis, Boulder, CO). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Until recently, home energy costs were seldom considered by lending institutions when the income required to qualify for a mortgage was determined. At current prices space conditioning and water heating costs can be a major portion of the homeowner's monthly expenditures. Determining the minimum income to qualify for a mortgage without considering the cost of energy may increase the incidence of default in the event of another rapid surge in energy prices. In addition, some prospective buyers of energy efficient homes may be disqualified due to the higher mortgage payments, even though the extra energy saving features may actually lower their total liability. To assist lenders in establishing income requirements and promote the construction and marketability of energy efficient housing, an automated analysis technique, was developed, which has been applied to numerous homes in the metro Denver area. The underlying principle of the analysis is that the net liability should be no greater for purchasing an energy efficient home than for a similar home with no energy saving features beyond those required by applicable building codes. The results of the analysis are automatically incorporated in a customized report known as the Home Ownership Mortgage Evaluation (HOME). A companion document for prospective buyers, which shows the ownership obligations and energy requirements in detail, is also generated. The latter report is called the Home Buyer's Energy and Financial Analysis Statement. Using the Home technique, it has been shown that appropriate energy saving measures can significantly reduce the net ownership obligations compared to a home built to minimum code requirements, and therefore also lower the minimum qualifying income.

32045 (CONF-850241—, pp 27-36) **ENERSAVE: a program to calculate energy cost savings.** Pollock, B.L. (Integrated Energy Systems Inc., Chapel Hill, NC). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

ENERSAVE is a program designed to compute the dollar value of annual energy cost savings in buildings in which energy conservation measures have been undertaken. It compares past years' and current year's energy use on a monthly basis using the rate schedules and prices in effect at the end of the current year. It also allows for adjustments due to changes in weather conditions, occupancy, area, and equipment. Electric cost savings calculated using ENERSAVE differ substantially from savings calculated using a current year average cost per kWh.

32046 (CONF-850241—, pp 45-49) **Energy signature monitor (ESM), a low cost Class B data acquisition system.** Szydlowski, R.F. (Lawrence Berkeley Lab., CA). May 1985. NTIS, PC A16. File Number DE86007106. Contract AC03-76SF00098.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The Lawrence Berkeley Laboratory, DOE, has developed the Energy Signature Monitor (ESM), an innovative data acquisition system which addresses the data acquisition and analysis requirements of test programs which involve monitoring of large samples of buildings. Information about typical number of sensors and accuracy requirements for such large monitoring projects was incorporated into the development of the ESM in order to meet the needs of most researchers without adding unnecessary, and expensive, features. The ESM hardware includes a microprocessor controlled data acquisition program, sixteen analog channels, two pulse count channels, an RS232 computer interface, and a removable EPROM-based data storage module. In conjunction with the hardware a complete data management software package, written to operate on a personal computer, was developed to facilitate analysis of the recorded data. A total of 23 ESMs have been built to date, all of which are being used in a field monitoring study currently being conducted by Lawrence Berkeley Laboratory. Technical support is being provided to two private sector companies that are interested in marketing a commercial version of the ESM.

32047 (CONF-850241—, pp 51-54) **Building energy monitoring and analysis (BEMA).** Spears, J.W. (NAHB Research Foundation, Inc., Rockville, MD). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The NAHB Research Foundation, Inc., is developing a residential Building Energy and Monitoring and Analysis system (BEMA) under contract to the US Department of Energy. The program is the home building industry's response to the techniques and methods developed under the Solar Energy Research Institute (SERI) Class B Passive Solar Monitoring Program. The BEMA program is continuing to refine the equipment, the methodology, and the technology used in the monitoring and analysis of buildings in order to provide the building industry with clear and reliable thermal performance data on buildings in a cost-effective manner. The techniques, methodology, and equipment used in the program are described.

32048 (CONF-850241—, pp 77-81) **Energy models: exploring the mini- and microcomputers' applications.** Rees, J.; Shedd, A.C. (Newcomb & Boyd, Atlanta, GA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Computer modeling techniques are becoming an increasingly common engineering tool. In an effort to evaluate the software available for this purpose, five of the most popular programs are used to model a typical low rise commercial office building. The results of each program are compared to historical data and to the results of the other programs. Results indicate that with proper care and engineering judgment, acceptable accuracy can be achieved. Using historical utility data to validate the computer model, acceptably accurate evaluations of mechanical and architectural modifications could be made. Without such validation the models were not found to predict energy consumption with sufficient accuracy.

32049 (CONF-850241—, pp 83-89) **Review of state-of-the-art in building energy design tools.** Anderson, D.L.; Jones, N.S.; Gordon, H.T. (Burt Hill Kosar Rittelmann Associates, Washington, DC). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

An assessment of the state-of-the-art in building energy design tools has been done as part of program support work for the US Department of Energy's Passive and Hybrid Solar Energy Division. It draws from the Building Design Tool Council's (BOTC) 1983 survey of design tool users and developers, the International Energy Agency's (IEA) 1982 and 1984 surveys of available building energy design tools, and discussions with key individuals in the design tool community. The BOTC users and developers surveys provided the background necessary to create a profile of the individuals now involved in the use and development of building energy design tools, and some insight into the lack of acceptance of design tools by builders, architects, and developers. The two IEA surveys offered detailed information as to the type, number and capability of currently available design tools. Trends were statistically generated for a variety of pertinent design tool characteristics, including capability, building type, intended users, and design phase. Based on these surveys and the observed trends, the nature and direction of the current building energy design tool market has been described.

32050 (CONF-850241—, pp 91-96) **Ten principles for the design of user-friendly design tools.** Milne, M. (Univ. of California, Los Angeles). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The phrase User-Friendly has become almost a cliche. It gets applied to so many different things that it nearly seems meaningless, yet it is a concept of critical importance in the development of micro-computer design tools for architects.

32051 (CONF-850241—, pp 111-124) **Experiences in monitoring the thermal performance of an earth-sheltered quadruplex.** Francetic, J.S.; Marlatt, W.P. (Energy Technology Engineering Center, Canoga Park, CA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Monitoring the energy consumption characteristics and other performance indicators of an earth-sheltered housing structure in southwestern Arizona for the US Navy is discussed. In particular, the objectives of the study, the unique features of the building, the data acquisition hardware and software used in the study, and the data reduction techniques used in analyzing the data are presented. Also discussed are actual experiences and lessons learned relative to the selection, installation, operation, and maintenance of portable data acquisition equipment for use in the field. Common occurring problems and recommendations for avoiding or eliminating such problems are given.

32052 (CONF-850241—, pp 145-149) **Model of residential cogeneration combining microcomputer and mainframe programs.** Rodberg, L.S. (Queens Univ., Flushing, NY). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A cogeneration analysis program utilizing both microcomputer and mainframe programs has been developed to describe the behavior of cogeneration-based energy systems in high-rise buildings and rowhouses having from ten to several hundred dwelling units. The program is designed to be used by building owners and residents. For any specified building, it identifies the most cost-effective cogeneration systems. Information is provided on energy consumption before and after the installation of these cogeneration systems, and a series of economic analyses is performed. The program uses a three-stage analytical process which begins with a microcomputer-based data entry program to which the user, at any level of expertise, can have ready access. Using building information applied by the user, this program identifies the optimal cogeneration systems operation in stand-alone, segregated-load, and utility back-up modes. This information, along with the other building data, is converted into a format suitable for input into the mainframe-based DOE-2 Building Energy Analysis System. A file con-

taining this input data is transmitted to a mainframe computer, where an hour-by-hour computation of the annual energy demand and equipment operation is performed. The authors use a version of DOE-2 which has been specially modified to save the results of its analysis in a data file. This file is transmitted back to the microcomputer, where the data are analyzed using an energy and economic analysis program developed for this purpose. Using the program, the cost-effectiveness for a typical 12-story, 48-unit apartment building in New York City has been analyzed. Payback periods of from one to three years are found for the utility backup mode.

32053 (CONF-850241—, pp 159-162) **Using a microcomputer for the evaluation of heat pump water heaters in the food service environment.** Borton, D.N.; Rogers, W.E.; Mitchell, R. (Power Kinetics Inc., Troy, NY). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

This project uses a microcomputer-based data acquisition system to evaluate water heating systems. The acquisition system monitors air-to-water heat-pump water heaters in three different types of dining facilities. From the data acquired, it is possible to evaluate the energy performance of the heat pumps as well as economics and kitchen environmental factors. The data acquisition system can be applied generally to many types of monitoring situations.

32054 (CONF-850241—, pp 163-171) **Microcomputer based university utility management and planning.** Fazzolare, R.; Horning, H.; Wanek, L. (Univ. of Arizona, Tucson, AZ). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A microcomputer based spreadsheet program provides a very effective energy management tool for large facilities such as a university campus. The spreadsheet program can be used for utility cost accounting, forecasting and budgeting, and the tracking of building energy costs. The LOTUS 1-2-3 program, running on an IBM PC, serves as an ideal framework for such a project. An integrated program such as 1-2-3 enables easy graphical presentation of pertinent information from the database, and allows for sophisticated programming of engineering models. The building energy costs are derived by 1-2-3 based on a monthly temperature bin model of the loads for the envelope, internal gains, and the air distribution systems. Frequency of occurrence charts are then used to weight the loads in each temperature bin, which ultimately yields total energy cost and use estimates for each month according to the (lighting, equipment, heating, or cooling) and function classroom, office, laboratory, study, residential, etc.).

32055 (CONF-850241—, pp 175-185) **Computer program to determine thermodynamic properties of moist air.** McMillan, H.K.; Kim, J. (Univ. of South Carolina, Columbia). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A knowledge of thermodynamic property values of moist air is essential in the design and analysis of HVAC systems. Historically these values have been obtained graphically from psychrometric charts. An interactive computer program to obtain psychrometric properties over the normal temperature range 30 F to 120 F and at or close to standard atmospheric pressure is described. The program was written with the following three objectives and criteria in mind: (1) it be as short and simple as possible, thus making it appropriate for use with microcomputers; (2) it must yield accurate results, (error $< +$ 1%); and (3) it must be simple to use or friendly. The program is menu-driven. The three inputs are: (1) barometric pressure: (2) dry bulb temperature: and (3) a choice of either wet bulb temperature, dew point temperature, or relative humidity. User must choose between SI or English units. The eight outputs are: barometric pressure; dry bulb, wet bulb, and dew point temperatures; relative humidity; humidity ratio; specific enthalpy; and specific volume. Although written as a stand-alone program, it is easily adaptable for use as a subroutine if desired. The program is written in basic to run on an IBM PC. A fortran version is also available. The program utilizes equations relating saturation pressure and saturation temperature that were obtained by least squares curve fit to steam table property values. Perfect gas behavior is assumed for both the dry air and water vapor and Dalton's law for partial pressures is utilized. A significant number of points have been checked with various inputs to determine output accuracy using the ASHRAE tables for thermodynamic properties of moist air as standard. All checks have yielded errors less than 0.5%.

32056 (CONF-850241—, pp 187-191) **Energy mapping and analysis procedures (EMAPS) as building diagnostics.** Cristensen, C. (Solar Energy Research Institute, Golden, CO). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Energy Mapping and Analysis Procedures (EMAPs) were developed to concisely display large amounts of hourly data. Energy Maps are generated using computer graphics to map hourly values into a time-of-day by time-of-year format. This approach has several advantages: (1) complete hourly data for several months or an entire year can be compactly displayed, (2) the graphic format reveals daily patterns, day-to-day variations, and seasonal trends, and (3) the same method can be used for a wide range of variable types. A monochromatic version of Energy Maps for use with typical microcomputers and printers is introduced. Procedures for using and interpreting Energy Maps are suggested and demonstrated. Energy Maps based on measured data are presented for solar radiation, outdoor temperature, building heating energy use, and indoor temperatures.

32057 (CONF-850241—, pp 201-205) **Kieper Method: computer application on moisture migration.** Mei, H.T. (Lamar Univ., Beaumont, TX). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Currently, only a few methods are available to analyze vapor migration through walls and to assess the potential for condensation, and they are all based on the steady state model. The Dew-point Method, described in the ASHRAE Handbook of Fundamentals, is the most widely accepted. Introduced in the early 1960's, an improved German version known as the Glaser Method is occasionally employed. These two methods, unfortunately, are both time-consuming and difficult to use. In 1976, another German version called the Kieper Method was developed and introduced as an alternative. It attracted relatively little attention and has remained practically unknown. The ASHRAE, the Glaser, and the Kieper Method are compared. In an attempt to offer greater accessibility to this method, the writer has developed a micro-computer package which will show the Kieper Diagram on a monitor, based on the given indoor and outdoor conditions, and plot the wall profile through the given wall's thermal and vapor diffusion resistance properties. The designer then can examine the results and options to make a final design decision. The most impressive feature is that the whole procedure only takes a few minutes, and the printer will provide a hard copy, if so desired. This application makes the Kieper Method ideal for practical design.

32058 (CONF-850241—, pp 209-214) **Microcomputer application for design and optimization of thermal energy storage system.** Torab, H.; Beasley, D.E. (Gannon Univ., Erie, PA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The algorithm for optimization of the design of a packed bed thermal energy storage unit is presented. A one-dimensional, transient, two-phase model is chosen for the packed bed which assumes uniformity at each cross section within the packing. The governing equations for the time dependent temperature distributions in both the solid and fluid phases are solved using a fully implicit numerical formulation. The accuracy of the numerical method is demonstrated by comparison with experimental measurements of temperature

distribution in a randomly packed bed of uniform spheres. The goal of the optimization is to achieve maximum utilization of the thermal energy storage and recovery capabilities of the storage medium for a given set of operating conditions. The optimum combination of bed length, size of the packing particles, and relative size of the bed cross-section to the particle diameter is determined, subject to constraints on the maximum allowable pressure drop across the packing, the maximum outlet fluid temperature, and the total amount of supplied energy. The thermodynamic availability is examined as the measure of storage utilization, and gives indication of the quality of the recoverable energy.

32059 (CONF-850241—, pp 271-276) **Preliminary validation of EEDO: energy economics of design options.** Amned, S.F. (Burt Hill Kosar Rittelmann Associates, Butler, PA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Energy Economics of Design Options, EEDO, the IBM-PC version of CIRA was evaluated for a number of different home types and three cities. The results were compared with a dynamic simulation program, SERI-RES and other design tools from 14 countries. The results of this evaluation have indicated that calculations made by EEDO and SERI-RES are in fairly good agreement on a yearly basis. The monthly energy calculations are mostly within +/- 10% of SERI-RES except for the house with sunspace. The methodology for the evaluation and some results are discussed.

32060 (CONF-850241—, pp 277-288) **UCSD Pascal intrinsic units used to create a file driven early design energy analysis program with input error checking automatically provided by the UCSD Pascal compiler.** Bovill, C. (Univ. of Tennessee, Knoxville). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

An energy analysis program (Energylook) was written to automate the energy graphics procedure. The program was structured as an intrinsic unit in the Apple UCSD Pascal system. This method produced a file driven energy analysis program with high quality input error checking provided by the Apple UCSD Pascal Compiler. No input error checking code needed to be written. The input takes the form of a Pascal program. It is created in the Pascal Editor and then compiled and run. Improper input (misspellings, incorrect data type, not enough parameters in a list, etc.) are caught by the Pascal Compiler with the option of automatic return to the Pascal Editor with the point of error marked and type of error described. In addition, since an intrinsic unit is an extension of the Pascal language, its procedures can be imbedded in a more complex analysis if desired.

32061 (CONF-850241—, pp 289-294) **Microcomputer based integrated energy design expert systems: a powerful new tool.** Schmitt, G.N. (Carnegie-Mellon Univ., Pittsburgh, PA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The present degrees of integration of experience and transdisciplinary expert knowledge into microcomputer analysis and simulation programs are a limitation to their usefulness in the design process. The structure and underlying theories of existing programs are identified as one of the roots of this problem. The maturing of expert system techniques is described as a possible way to a solution. A well defined problem is presented, the interactive energy modeling and optimization process of a building in the schematic design phase is proposed; and MBIEDES1, a pilot microcomputer based integrated energy design expert system to combine and improve existing methods is proposed. A number of energy and graphics programs are evaluated for this purpose and interaction principles are discussed. Three programs are chosen for combination to form the first version of MBIEDES1. The human knowledge resources and the necessary computer resources are identified. A high level user interface is described.

32062 (CONF-850241—, pp 295-298) **Visual thermal analysis.** Zdepski, M.S. (New Jersey Institute of Technology, Newark). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Numerous mainframe, and microcomputer thermal analysis programs exist in the professional marketplace. However, most programs are compiled, have restricted access or are limited to specific computer systems. More importantly, most of the current software is oriented toward post-design analysis, rather than providing information about the relative importance of the many design and technical choices available to the architect or engineer in the early design stage. Most analysis models utilize the microcomputer to facilitate the processing of large amounts of numeric data, and do not take advantage of the graphic capabilities of the small computer. There is no comprehensive model which is suitable throughout the design process, to permit increased levels of sophistication, choices in technical variables being considered, providing detailed information about various climatic events, changing comfort conditions, short and long term energy analysis, and assistance in the development of physical design strategies.

32063 (CONF-850241—, pp 299-303) **Microcomputer program for energy analysis of residences.** Ritschard, R.; Huang, J.; Byrne, S.; Bull, J. (Lawrence Berkeley Lab., CA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The Building Energy Analysis Group has designed a computerized version of its comprehensive DOE-2.1 residential data base, which was developed in support of a national home builders' guide and accompanying slide rules for single-family houses. The software package called PEAR (Program for Energy Analysis of Residences) is written with user-friendly input and output, and runs on the IBM PC with either color or monochromatic monitors. PEAR is based on the results of over 12,000 computer simulations using the DOE-2.1 code and a variety of interpolative procedures such as linear and nonlinear regression, multivariate analysis of variance, and other methods that correlate simulated data to important climate and building design variables. The current version covers five residential building prototypes in 45 base locations but can be extended to 800 other locations by using heating and cooling degree-day modifications. The program allows adjustments to the building prototypes for differing window area and location as well as floor area, gross wall area, and perimeter length. In addition to the typical conservation measures such as ceiling, wall and floor insulation, window type and glazing layers, the user can adjust for optional measures such as roof or wall color, movable insulation, whole-house fans, night temperature setback, reflective or heat absorbing glass, and two attached sunspace options. The purpose of this research is to develop simplified energy calculation procedures capable of accurately estimating energy and cost savings associated with various conservation measures. The program is designed to be used both as a research tool by energy and policy analyst, and as a non-technical energy calculation tool by architects, home builders, home owners, and others in the building industry.

32064 (CONF-850241—, pp 305-316) **solASEC: an education thermal analysis program for a continuum of designs from classical passive through superinsulation.** Peck, J.F.; Fazzolare, R.A.; Thompson, T.L.; Mignon, G.V. (Univ. of Arizona, Tucson). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

solASEC is a simplified thermal analysis program for passive solar through superinsulated residences or small buildings. It was developed in response to the need for a program with the following goals: (1) It should be an easy to use, unintimidating program that can be used at several skill levels, and grow as the user's skills increase. (2) It should be capable of handling cost common design options, as well as the devices developed and analyzed at the Envi-

ronmental Research Laboratory. The latter are especially useful in desert climates. Each version should contain the basic weather data for a given program between various brands of computers. (3) The program should be in a common compilable language. (4) The program should be unprotected, and the programming unsophisticated, so it can serve as a basic for the development of more sophisticated programs by students and professionals, once they have mastered the simple program. The solASEC program architecture and operation are described.

32065 (CONF-850241—, pp 337-343) **Methodology for hourly simulation of residential HVAC equipment.** Huizenga, C.; Barnaby, C.S. (Berkeley Solar Group, CA). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

Hourly building energy simulation programs for microcomputers are becoming increasingly popular tools for building design. An important aspect of these programs is the manner in which they treat the performance of heating and cooling equipment. Many existing models are either too simplified or require equipment performance data which is not readily available. A simplified methodology for hourly heat pump, air-conditioner and gas furnace models which make use of readily available data and are appropriate for microcomputer applications is presented. At a minimum, published American Refrigeration Institute (ARI) and Department of Energy (DOE) performance data can be used as input. Using this data, it is possible to develop relationships between equipment performance and ambient conditions. If more detailed performance data is available, it can be used to improve the accuracy of the simulation. In addition to equipment performance data, the method requires hourly weather, building load, and indoor temperature data.

32066 (DOE/CE/15240—T2) **Insulated siding. Quarterly technical progress report.** (Ball State Univ., Muncie, IN (USA). Center for Energy Research/Education/Service). 30 Apr 1986. Contract FG01-85CE15240. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009827.

A brief discussion on the research and development of insulated vinyl siding is presented. (BCS)

32067 (DOE/CE/30750—T1) **Architecture, energy and education. Case studies in the evaluation of the teaching passive design in architecture workbook series.** Shibley, R.G.; Poltroneri, L. (Association of Collegiate Schools of Architecture, Washington, DC (USA)). Feb 1984. Contract AC02-82CE30750. 56p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010407.

The research, design, and curricular explorations reported herein demonstrate a wide range of approaches to teaching energy in design. However, the work is not primarily a demonstration of energy education. It is an evaluation of architectural education approaches. The placement of value on how one teaches and what one chooses to teach is at the core of all academic experience. The nine schools which have participated in this program have been reflecting rigorously on the value of their teaching approaches, resource materials, and fundamental assumptions for two years. The result is perhaps most significant for what it illustrates about how we come to put value on the teaching of architecture. Energy, in this case, is the vehicle through which we have attempted to better understand architectural education. Energy, alone, is not the subject of this text.

32068 (K/CSD/TM—59) **Calculation of heat flux through a wall containing a cavity: comparison of several models.** Park, J.E.; Kirkpatrick, J.R.; Tunstall, J.N.; Childs, K.W. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Feb 1986. Contract AC05-84OT21400. 30p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010348.

This paper describes the calculation of the heat transfer through the standard stud wall structure of a residential building. The wall cavity contains no insulation. Results from five test cases are presented. The first four represent progressively more complicated approximations to the heat transfer through and within a hollow wall structure. The fifth adds the model components necessary to severely inhibit the radiative energy transport across the empty cavity. Flow within the wall cavity is calculated from the Navier-Stokes equations and the energy conservation equation for an ideal gas using an improvement to the Implicit-Compressible Eulerian (ICE) algorithm of Harlow and Amsden. An algorithm is described to efficiently couple the fluid flow calculations to the radiation-conduction model for the solid portions of the system. Results indicate that conduction through still plates contributes less than 2% of the total heat transferred through a composite wall. All of the other elements (conduction through wall board, sheathing, and siding; convection from siding and wallboard to ambients; and radiation across the wall cavity) are required to accurately predict the heat transfer through a wall. Addition of a foil liner on one inner surface of the wall cavity reduces the total heat transferred by almost 50%.

32069 (LBL—19550) **Toward accurate prediction of comparative fenestration performance.** Klems, J.H. (Lawrence Berkeley Lab., CA (USA)). Apr 1985. Contract AC03-76SF00098. 26p. (EEB-W—85-08; CONF-850237—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86009923.

From International workshop on measuring thermal performance characteristics of windows; Gaithersburg, MD, USA (26 Feb 1985).

The importance of going beyond laboratory measurements to prediction of field performance of fenestration systems is noted. The current state of the art in energy prediction related to fenestrations is discussed; a critique of the ASHRAE U-value is presented, and current questions about film coefficients are put into context. Ambiguities in the modeling of complex glazing systems are pointed out. Several questions about the convective processes in simple enclosures are raised, and the importance and uncertainty of solar gain calculations is underlined. It is concluded that accurate field measurements are needed to inform the predictive enterprise. A facility to make these measurements is described and current progress on calibrating this facility is presented.

32070 (LBL—20213) **Window performance and building energy use. Some technical options for increasing energy efficiency.** Selkowitz, S. (Lawrence Berkeley Lab., CA (USA)). Jun 1985. Contract AC03-76SF00098. 16p. (EEB-W—86-05; CONF-8504174—4). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009924.

From Energy sources: conservation and renewables; Washington, DC, USA (27 Apr 1985).

Window system design and operation has a major impact on energy use in buildings as well as on occupants' thermal and visual comfort. Window performance will be a function of optical and thermal properties, window management strategies, climate and orientation, and building type and occupancy. In residences, heat loss control is a primary concern, followed by sun control in more southerly climates. In commercial buildings, the daylight provided by windows may be the major energy benefits but solar gain must be controlled so that increased cooling loads do not exceed daylighting savings. Reductions in peak electrical demand and HVAC system size may also be possible in well-designed daylighted buildings.

32071 (LBL—20874) **Measured energy savings in retrofitted multifamily buildings.** Goldman, C.A.; Greely, K.M. (Lawrence Berkeley Lab., CA (USA)). Jan 1986. Contract AC03-76SF00098. 19p. (EEB-BED—86-01; CONF-860303—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009927.

From 13. annual energy technology conference and exposition (ET '86); Washington, DC, USA (17 Mar 1986).

Measured data on the energy savings and cost-effectiveness of conservation measures and practices installed in existing multifamily buildings are compiled and analyzed for over 100 buildings. Factors that explain the range in energy savings are analyzed including energy use before the retrofit, the level of investment, and choice of measures. Energy savings achieved are typically 10 to 25% of pre-retrofit energy use although large variations are observed in energy savings and in costs per unit of energy saved. The median retrofit investment in multifamily buildings is ~$530 per

unit. Many conservation investments are attractive investments from a building owner's perspective: the median real rate of return for buildings in this study is 22%. Preliminary results also suggest that some envelope measures (e.g., "shell" packages and window measures) have longer payback periods than many of the heating system retrofit strategies.

32072 **(ORNL/CON—194) Electricity savings one to three years after participation in the BPA residential weatherization program.** Goeltz, R.; Hirst, E.; Trumble, D. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 51p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86009999.

During 1982 and 1983, the Bonneville Power Administration operated an interim Residential Weatherization Program throughout the four-state Pacific Northwest region. Households that participated in the program received free home energy audits and financial assistance (usually cash rebates) to help pay for installation of retrofit measures in their homes. Almost 104 thousand homes were retrofit during the two years that the program operated; BPA's cost to run the program totaled almost $160 million. The purpose of these update is to estimate electricity savings both one and two year after the interim program ended. This update is intended to determine whether program-induced electricity savings change over time. Therefore, an additional year of electricity billing data (1984/85) was collected for samples of participant and nonparticipant households. Complete data are available for 850 program participants and 280 nonparticipants, about 85% of the sample used in the original evaluation. These 15% were "lost" because of household moves, changes in participation status for some nonparticipants, and because of errors in the billing data. Daily temperature data for the 32 weather stations and recent changes in residential electricity prices were also obtained for this update.

32073 **(PB—86-157161/XAB) Economic-screening guidebook for cogeneration in buildings. Report for January 1983-November 1985.** Bos, P.G.; Davis, S.A. (ARS Group, Inc., Wellesley, MA (USA)). Nov 1985. 570p. NTIS, PC A24/MF A01.

Previous economic assessments of cogeneration applications in buildings have been of limited value because of the absence of meaningful load-profile data, failure to identify viable alternative configurations, inappropriate assumptions about investment-decision criteria, and uncertainty about installed costs. As a result, GRI conducted an in-depth regional assessment to develop energy-savings data for a range of building-technology-region combinations. The output of the assessment was an economic screening guidebook for GRI's analysis of specific cogeneration applications. The building types/sizes covered were: hospitals (348 beds); hotels (414 and 102 rooms); office buildings (12 and 4 stories); apartment buildings (149 and 48 units); and restaurants (9000 sq. ft.). The reference competitive technologies used were: engine generator system with a heat-recovery boiler (100-1050 kW) and a gas-turbine generator with a heat recovery boiler (500 and 800 kW). The regions covered were: Northeast; Southeast, Midwest; Southwest; Rocky Moutains; and Lower West Coast.

32074 **(PB—86-157476/XAB) Development of advanced residential range burners with low NOx characteristics. Phase 2. Final report.** DeWerth, D.W.; Sterbik, W.G. (American Gas Association Labs., Cleveland, OH). May 1985. 53p. NTIS, PC A04/MF A01.

The report covers the work completed during June 1984 to May 1985. Discussed is the development of a production-type wire insert in cooperation with a major range manufacturer which reduced the NOx and NO_2 in a range top burner 35 and 26% respectively. The device is a simple burner add-on that can be economically manufactured. This report also discusses the development of a low-NOx dual-rod-insert oven burner. The addition of the dual-rod inserts to the oven burner reduced the NOx by 63% and the NO_2 by 25%. Also discussed are the results of a limited field test of the range-top burner wire inserts at three field test sites. Preliminary field-test evaluation reports have not indicated any serious shortcomings of the device. Lastly, discussed in this report are the results of an alternate low-NOx range top burner design that employed high primary aeration as a NOx (NO2) reduction means.

32075 **(PB—86-161478/XAB) Commercial-sector energy use in Christchurch. Final report.** (Morris (R.W.) and Associates, Christchurch (New Zealand)). Sep 1985. 35p. NTIS, PC A03/MF E01.

The report presents the results of a study of energy usage in commercial buildings in Christchurch based on a survey of a random sample of buildings from this sector. Energy data were recorded from a field survey of 223 commercial buildings housing 485 tenants. The energy consumption for each building and tenant was obtained from the relevant energy-supply authorities for electricity, oil, coal gas and coal for the period 1st June 1979 to 31st May 1980. The building characteristics were obtained by surveyors entering each building and recording the information gained from measurements and interviewing owners, occupiers and building supervisors.

32076 **(PB—86-163722/XAB) Double effect absorption heat pump. Phase 2 and 2A. Final report, October 1982-May 1984.** Cook, F.B.; Cremean, S.P.; Jatana, S.C.; Johnson, R.A.; Malcosky, N.D. (Columbia Gas System Service Corp., Columbus, OH (USA)). 30 Sep 1984. 153p. NTIS, PC A08/MF A01.

The objective of the program is research, development, and demonstration of a double-effect generator-cycle absorption heat pump for residential and small commercial markets. During Phases II and IIA, a 3RT advanced breadboard air-to-air reverse cycle heat pump was designed, fabricated, and tested and the heating and cooling targets were achieved. The parasitic power consumption targets were not demonstrated in these phases. The refrigerant-generator/heat-exchanger subsystem, the interface heat exchangers, and prototype solution pumps based on three different pumping technologies were designed, fabricated, tested, and delivered by Columbia subcontractors. Development of a packaged prototype heat pump based on components and subsystems designed in these phases is recommended.

32077 **(PB—86-163789/XAB) High-efficiency commercial water-heater development. Supplemental technical report, August 1984-August 1985.** Sespaniak, M.P.; Demetri, E.P.; Gerstmann, J. (Advanced Mechanical Technology, Inc., Newton, MA (USA)). Aug 1985. 43p. NTIS, PC A03/MF A01.

The development of a condensing water heater for commercial applications was completed. The selected concept consists of a high-efficiency water heater connected by appropriate plumbing to a stratified-temperature storage tank. A number of pre-production prototypes were fabricated and installed at nine representative commercial sites. An initial year of field tests, starting in April 1983 and concluding in July 1984, consisted of a side-by-side comparison with the existing conventional water heater at each site. The test results obtained demonstrate standby loss rates less than one-fifth of conventional values and service efficiencies which average 32% higher than conventional-system efficiencies.

32078 **(PB—86-168267/XAB) Modeling of a heat pump charged with a non-azeotropic refrigerant mixture. Final report.** Domanski, P. (National Bureau of Standards, Washington, DC (USA). Building Equipment Div.). Jan 1986. 396p. (NBS/TN—1218). NTIS, PC A17/MF A01.

An analysis of the vapor-compression cycle and the main components of an air-to-air heat pump charged with a binary non-azeotropic mixture was performed for steady-state operation. The general heat-pump simulation model HPBI was formulated, based on independent, analytical models of system components and the logic linking them together. The logic of the program requires an iterative solution of refrigerant pressure and enthalpy balances, and refrigerant mixture and individual-mixture-component mass inventories. The modeling effort emphasis was on the local thermodynamic phenomena described by fundamental heat-transfer equations and equation-of-state relationships among material properties. In the compressor model, several refrigerant locations were identified and the processes taking place between these locations accounted for all significant heat and pressure losses.

32079 (TTKK-ST—1983/7) Control of heating systems in buildings. Koivisto, H.; Karttunen, P.; Katajisto, K.; Pajunen, T.; Vaittinen, R.; Haavisto, J.; Karhunen, J.; Ahvenjaervi, S. (Tampere Univ. of Technology (Finland). Control Engineering). Dec 1983. 211p. (In Finnish). Tampere Univ. of Technology (Finland). Control Engineering.

In this study is considered the control of heating systems in buildings. The study consists of three parts. In the first part the control of heating distribution systems in buildings is considered. A computer program was created to simulate the thermal behaviour of building. The building thermal behaviour was simulated with 20 ordinary differential equations/room. This simulation program was used to develop control systems for space heating in buildings. The second part of this study considers the control of the local heat exchanger in district heating systems. This was studied by simulation and by experimental work. In the third part of this study the control of combined heating systems is considered. This part consists of several simulation and experimental case studies. First, the solar collector systems were studied by simulation program. The optimum sizing, the annual energy conservation and the effect of control system was analysed. In the experimental part considering the control of the combined heating systems two case studies were done. The increasing the heat factor of the heat pump by using more efficient control system was studied by laboratory experiments. Finally, the behaviour of one combined heating system was analysed by measurements made in test building.

32080 Residential applications of energy rating systems. Friedrichs, M.D. (Dept. of Energy, Washington, DC). *Energy Technology (Washington, D.C.);* **12**: 653-659(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

DOE supports non-federal efforts to provide home energy ratings because a major factor reducing the effectiveness of market forces in this area is the inability of consumers and lenders to determine the true value of most home conservation investments. Rating systems range from simple prescriptive standards to sophisticated computer models which attempt to predict the energy use and costs of new or existing homes, yet most have been less than successful. Experience suggests that an effective rating system must (1) be designed for use in both the marketing of homes to buyers and the mortgage lending process, (2) enjoy the acceptance or active support of a range of local organizations, (3) be comparatively simple and low cost, and (4) be a credible indicator of comparable home energy costs. DOE expects to initiate research to answer some of the questions and to operate as a resource for voluntary rating programs.

32081 Lighting control equipment and applications. Verderber, R.R. (Lawrence Berkeley Lab., CA). *Energy Technology (Washington, D.C.);* **12**: 679-687(Aug 1985). (CONF-850301—). Contract AC03-76SF00098.

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Lighting control equipment can minimize the energy consumed while providing the proper illumination of occupants' use of the space. The choice controls depends upon the particular application (retrofit, renovation, or new construction). The author presents a general approach for selecting appropriate equipment based on the interdependence of equipment, control strategies, major cost factors, and applications. There is a non-exclusive list of equipment under each category. 4 tables.

32082 Monitored energy performance of new retrofitted buildings: some results from the BECA data compilations. Meier, A.K. (Lawrence Berkeley Lab., CA). *Energy Technology (Washington, D.C.);* **12**: 704-713(Aug 1985). (CONF-850301—). Contract AC03-76SF00098.

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Compilations of measured energy performance of buildings cover new, low-conserving residential buildings, residential retrofits, new commercial buildings, and commercial retrofits from over a thousand studies consisting of about 50,000 buildings. The purpose of the databases is to develop techniques for characterizing measured building energy performance and identifying successful, cost-effective conservation and solar strategies. Any comparison of building energy performance requires a standardization procedure to ensure that all buildings are providing similar amenities. 6 references, 3 figures.

32083 Patching the thermal hole of windows. Potter, T.F. (Solar Energy Research Institute, Golden, CO). *Energy Technology (Washington, D.C.);* **12**: 718-727(Aug 1985). (CONF-850301—). Contract AC02-83CH10093.

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Two advanced window concepts promise to provide a changed perspective on building apertures. The smart window of the future will probably exhibit both the heat retention and controllable admittance features the author describes in his discussion of continuing efforts to improve the R-value of glazings. These efforts include evacuated glazings with internal spacers and infrared reflective film and thin-film multilayer electrochromic coatings using tungsten oxide. If preliminary work proceeds as planned, the building industry will be able to develop products that alter the way homes and offices are built and operated and which substantially decrease energy use. 13 references, 5 figures.

32084 BETT YARDSTICK: an apartment energy use database. Zaborowski, S.; Peters, R.; Mason, G. (Energy, Mines and Resources Canada, Ottawa, Ontario). *Energy Technology (Washington, D.C.);* **12**: 889-897(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The Building Energy Technology Transfer (BETT) YARDSTICK is a computerized database which can store data on up to 5000 apartment, provide owners with energy cost comparisons, and provide statistical analysis of apartments energy consumption. The author describes the system design, then gives a detailed summary of the three subsystems: apartment owners subsystem, system managers subsystem, and system security tables (which provide assigned identifiers and passwords to each user and allow different types of users access to different features of the system). Demonstrations found BETT YARDSTICK to be valuable for presenting energy savings potential to building owners and in deciding which building to consider first in a retrofit program. 5 figures.

32085 Advanced heat pump research and development sponsored by the US Department of Energy. Kuliasha, M.A. (Oak Ridge National Lab., TN). *Energy Technology (Washington, D.C.);* **12**: 898-907(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The DOE-sponsored Building Equipment Research (BER) program has projects to develop a technology base and generate new concepts for improving the energy efficiency and load characteristics of the energy-conversion equipment used in residential and commercial buildings. Recent accomplishments show promise for new thermally activated heat pump (TAHP) technologies, including advanced absorption heat pumps, Stirling engine-driven heat pumps, and internal combustion engine-driven heat pumps. A successful resolution of technical hurdles could reduce primary fuel consumed for heating, cooling, and water heating by 50%. Promising future technologies include dual-stroke compressors, advanced modulating heat pumps, zone control, cycle modifications to reduce dynamic losses, and advanced systems using nonazeotropic refrigerant mixtures. 5 references, 3 figures.

32086 Lighting research program. Berman, S. (Lawrence Berkeley Lab., CA). *Energy Technology (Washington, D.C.);* **12**: 918-927(Aug 1985). (CONF-850301—). Contract AC03-76SF00098.

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Energy-efficient lighting could reduce 50% of the electrical energy consumed by lighting (about 12% of total national electrical energy sales), which would yield a savings of 220 billion kWh of electricity. The DOE Lighting Program carried out at Lawrence Berkeley Laboratory helps manufacturers, designers, and users

achieve a more efficient lighting economy. The program is a unique partnership between a national laboratory/university complex and industry. The author describes the scope of the program under its three major categories of engineering science, electromagnetic compatibility, and impacts on human health and productivity. 4 tables.

32087 **Aerogel, a transparent insulator for solar applications.** Hunt, A.; Russo, R.; Tewari, P.; Lofftus, K. (Applied Science Div., Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 56 of Proceedings of Intersol 85. Ottawa, Ontario; SESCI (1985). (CONF-850604—).

From INTERSOL '85 - Solar energy--the diverse solution; Montreal, Canada (23 Jun 1985).

Transparent silica aergoels are being studied for their excellent thermal insulation properties for window glazing materials. The goals of the study are to improve the optical and thermal properties of aerogel, develop methods to protect it from environment, discover less expensive synthesis methods, and develop a technology base for production of transparent aerogels. Optical transmission, light scattering, microscopic and other data show that CO_2 supercritical drying of alcogels produces aerogels similar in quality to that of high temperature supercritical drying. Reproducibility of CO_2 drying method is far better than that of high temperature supercritical drying. CO_2 supercritical drying is simpler and economical because it is done at ∂ 40°C instead of at Γ 270°C and Γ 1700 psi. CO_2 method also saves significant time in the drying process. Exploring a wide range of process variables by factorial design set of experiments the authors have achieved a base catalyzed $Si(OC_2H_5)_4$ aerogel similar to quality to the one prepared by $Si(OCH_3)_4$.

32088 **Dual energy use for industrial, commerical, and building applications.** Biancardi, F.R.; Melikian, G.; Sgamboti, C.T. New York, NY; American Society of Mechanical Engineers (1985). 7p. American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017.

Integrated dual energy use systems, optimizes to provide both electrical (or mechanical) and thermal energy for industrial process heating/cooling or for commercial and residential space conditioning needs, are energy efficient and economic alternatives to conventional single-purpose energy systems. Numerous prime movers, including diesels, gas engines, steam and gas turbines, combined cycles, and other advanced conversion systems, together with an array of different primary energy sources such as gas, oil, coal, biomass and municipal solid waste fuels and thermal storage and control strategies, can result in a complex variety of system configurations. The United Technologies Research Center (UTRC), working with the U.S. Department of Energy, the Electric Power Research Institute, and state and local governments, has developed methodologies and procedures to screen, evaluate, and select optimum dual energy use systems (DEUS) for industrial parks, commercial developments and residential applications or combinations thereof. This paper describes methodologies developed and provides examples of the dual use energy systems defined for use in: (1) single industries, (2) multiple-industry industrial parks, (3) recovery of waste heat from a nuclear fuel processing facility, and (4) burning of solid and municipal waste sources. In addition, specific sites are described which include residential, commerical and industrial developments being implemented in the eastern and western sections of the United States.

32089 **Indoor air pollution to emissions from wood burning stoves.** Traynor, G.W.; Apte, M.G.; Carruthers, A.R.; Dillworth, J.F.; Grimsrud, D.T.; Gundel, L.A. (Lawrence Berkeley Lab., Berkeley, CA). *Proceedings, Annual Meeting, Air Pollution Control Association;* 2: 10(1984). (CONF-840612—). Contract AC03-76SF00098.

From Air Pollution Control Association annual meeting; San Francisco, CA, USA (25 Jun 1984).

Wood-burning stoves have been found under some conditions to contribute to indoor concentrations of carbon monoxide, nitric oxide, nitrogen dioxide, and suspended particles, including benzo-A-pyrene. Indoor pollutant emissions from wood-burning stoves can be emitted into the indoor environment during starting, stoking, and reloading operations, or they can be emitted continuously if a leak or crack exists in the stove or its vent system. In this study the authors investigate the impact on indoor air quality from the use of four different wood-burning stoves in an occupied house under simulated use conditions. Measurements of carbon monoxide (CO), nitric oxide, nitrogen dioxide, formaldehyde, total suspended particles, submicron suspended particles and five polynuclear aromatic hydrocarbons (PAH) are discussed in this paper. The PAH compounds investigated were benzo(B)fluoranthene, benzo(k)fluoranthene, benzo(A)pyrene, benzo(GHI)perylene, and indeno(1,2,3-CD)pyrene.

3202 Transportation

REFER ALSO TO CITATION(S) 31972, 31973

32090 **(AD-A—164216/4/XAB) Surface-ship fuel savings with an optimized autopilot. Master's thesis.** (Naval Postgraduate School, Monterey, CA (USA)). Dec 1985. 87p. NTIS, PC A05/MF A01.

In this thesis, the propulsion losses, which are caused by added drag due to steering of the ship, can be minimized by using an Adaptive Automatic Optimal Controller. It is shown that this Controller is capable of providing fuel savings in excess of 0.5% over a well-tuned PID controller when operating at the design speed at random headings in sea states. A new approach was used in finding fuel savings without using the engine specifications. It is shown that the second-order forces and moments create drift motions along the surge, sway, and yaw axes. As a consequence of this, the second-order forces and moments cause more fuel consumption than the first-order forces and moments cause more fuel consumption than the first-order forces and moments, which create only oscillatory ship motions along this axis. So the sea state in the deterministic model is represented by the first-order and second-order forces and moments.

3203 Industry And Agriculture

REFER ALSO TO CITATION(S) 31327, 31342, 31347, 31370, 31433, 31737, 31964, 32117, 32156, 32180

32091 **(BMFT-FB-T—85-161) Development and operation of a prototype plant comprising a bipolar membrane cell electrolyzer for the electrolysis of KCl. Final report.** Hausmann, E.; Neumann, B.; Will, H. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 29p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752000.

The conventional process for KCl electrolysis so far has been the mercury cell process. The semipermeable membrane process newly developed for the NaCl electrolysis was to be tested under this research program for the electrolysis of KCl as suitable membranes for KCl have become available. The new process was to reduce the energy consumption to 20% and to replace mercury which is a hazard for environment. To prove these aims, a prototype plant of a membrane cell for KCl electrolysis was designed and tested under industrial-scale operating conditions. The membrane cell electrolyzer was built in a particularly compact bipolar design allowing larger electrode surfaces. The cell was operated in parallel with an existing mercury cell plant so that additional steps of brine purification became necessary. The expected energy saving was proved. Sealing problems were solved, and the handling of the membrane was optimized. Krebskosmo membrane cell electrolyzers can be economically operated for the electrolysis of NaCl as well as for KCl. (orig.). With 12 figs.

32092 **(BNL—51978) Technical assessment of a direct contact heat exchanger as an energy conservation retrofit option.** McDonald, R.J.; Nally, J.D. (Brookhaven National Lab., Upton, NY (USA)). Dec 1985. Contract AC02-76CH00016. 82p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86009599.

The objective of this report is to present the results of an engineering analysis of the energy conservation potential of a direct contact heat recovery process applied to residential sized warm air furnaces. A laboratory study was conducted using both a gas-fired furnace and an oil-fired furnace. A series of measurements were

performed to measure various parameters associated with the test furnaces, both in a baseline condition and with direct contact heat exchangers added to the systems.

32093 (CONF-850241—, pp 13-22) **Energy conservation strategies: analysis of investment alternatives.** Sherry, W.J.; White, J.W. (Univ. of Illinois, Urbana). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

A method for evaluating the economic impact of various energy conservation investment proposals for commercial greenhouses was developed. Systems including multiple layer covers, thermal blanket insulation, alternative heat delivery methods and variable fuel sources can be evaluated. Analysis are conducted through internal rate of return determinations and required program inputs include: material, labor and installation costs; photosynthetically active radiation transmission; marginal tax rate; fuel cost and inflation prediction; heat transfer properties; crop value and inflation increase; eligibility for tax and investment credits and analysis period. Wide ranges of internal rates of return estimates were shown to be a function of the rate of fuel cost increases, eligibility for tax credits and life expectancy of the proposal. A sample output, including cash flow analysis is provided.

32094 (CONF-850241—, pp 133-137) **Irradiance and plant temperature monitor/controller.** White, J.W.; Hamilton, J.H. (Pennsylvania State Univ., University Park). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

An irradiance and plant temperature monitor/controller has been developed and is being tested for use in controlled environments and in commercial greenhouses. Photosynthetic photon flux density was monitored using a quantum sensor, while plant temperature was monitored with an infrared thermometer. A microprocessor integrated the signals from each sensor and permitted a choice of priority control of high intensity discharge (HID) lamps or infrared (IR) heaters for control of plant temperature. It also permits dimming of HID lamps inversely proportional to natural irradiance. Effects of the monitor/controller changes on high pressure sodium lamp output to input ratio, lamp life and dimming response time are illustrated. The effects of irradiance variations on leaf heating and cooling are presented.

32095 (CONF-850241—, pp 151-157) **Operating microprocessor based system for tracking energy use and cost.** Altschul, M.H. (Univ. of Virginia, Charlottesville). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

One of the essential elements of an energy management program is the accurate tracking of energy use and cost. It is important for cost centers to be held accountable for energy use, either by direct billing or through organizational channels. Such accountability is possible only if accurate energy use records are maintained in a readily available form. The volume of data required to track the energy use of even moderately sized institutional and industrial organizations approaches that needed to operate a small utility company. The University of Virginia has developed a system of databases and related dBASE II programs for tracking and importing energy consumption and boiler plant operations. The boiler plant routines provide a simple means of interactively entering and checking data related to daily plant operations. Other interactive routines are used to input raw data for other utility services. The energy tracking routines provide summaries of energy use on monthly or annual bases. In addition to providing a management tool for evaluating both campus-wide and building by building energy efficiency, this system is used as a means of billing various organizations within the University for energy used. The various data structures have been designed to account for the occasional unreliability of real world data and to provide an audit trail of adjustments to such data. The system is designed to allow for data entry by relatively unskilled personnel and allows managers to receive and analyze information in several convenient forms. All of the programs have been extensively revised to better reflect our understanding of how the data is gathered and used. While designed specifically for the unique operational requirements of the University of Virginia, this system of programs can easily be adopted for use by other institutions and industries.

32096 (CONF-850241—, pp 319-326) **Microcomputer program of crossflow cooling tower performance.** Reichelt, G.E.; Jones, J.W. (Black & Veatch, Kansas City, MO). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The energy use characteristics of evaporative cooling towers are of interest because, although such towers are widely used in industry, they do require a substantial amount of energy, Cooling towers are basically heat exchangers that use both sensible heat transfer and mass transfer to cool. The heat and mass transfer process for a crossflow cooling tower has been modeled on a Apple II microcomputer. Various heat loads or weather conditions can be imposed on a given tower to evaluate its response; moreover, a subprogram can evaluate pressure drop and motor/fan characteristics. Determination of the energy required to operate the tower enables its performance to be compared against energy-saving operations such as variable-speed drive or changes in fill height or type.

32097 (DOE/CE/40738—T1) **High-intensity drying processes, report one.** Sprague, C.H. (Institute of Paper Chemistry, Appleton, WI (USA)). Aug 1985. Contract FG02-85CE40738. 134p. NTIS, PC A07/MF A01; GPO Dep. File Number DE86010013.

Since 1980, a research program has been directed toward the investigation and evaluation of three advanced paper drying processes having potential benefits to the pulp and paper industry: elevated temperature/pressure drying, thermal/vacuum drying, and impulse drying. They all involve intensive heat input, resulting in the development of vapor pressures inside the sheet that exceed the ambient pressure. The conditions required for intensive heating, together with the vapor pressure that results, provide the basis for the following significant potential benefits of high-intensity drying: very high drying rate, reduced quantity and/or quality of drying energy, and favorable impact on paper properties. This report focuses on the two major aspects of the completed research in the high-intensity drying area: exploratory studies of the performance of these processes and development of a process description based on detailed experimental and mathematical analyses. The report concludes with a long-range plan for future work.

32098 (DOE/METC—86/6036-Vol.2, pp 629-637) **Process for extraction of mineral values from low rank coals.** Greene, M.M. (MultiTech, Butte, MT). Feb 1986. NTIS, PC A14/MF A01. File Number DE86001077. (CONF-850565—Vol.2).

From 13. biennial lignite symposium on technology and use of low-rank coals; Bismarck, ND, USA (21 May 1985).

A process is described for extraction of mineral values from low rank coal-ash with high alkaline content employing hydrochloric acid as the extractant. Flow diagrams with mass flows are included for the process. Essential economic data are included. Separation of products from the extract solutions is discussed. The process features a closed acid-and-water balance. Data were developed from power plant scrubber sludge. 7 refs., 4 figs., 2 tabs.

32099 (EEO—57/75) **Installation of a direct fired Lanham bread baking system. A demonstration at Family Loaf Bakery Ltd. [Bristol].** (PIRA, Leatherhead (UK); Atkins (W.S.) and Partners, Epsom (UK)). Oct 1985. 38p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751858.

The first installation in the UK of a direct-fired continuous conveyor oven capable of producing 8,500 loaves/hour has reduced energy costs at Family Loaf Bakery's Avonmouth plant by pound 66,680/year and resulted in net cost savings to the company of pound 59,680/year. This saving was achieved by using a direct-

fired oven which had a low thermal mass and small oven openings. When baking identical products, a 30% saving in oven fuel was obtained using the new system compared to conventional systems. For this bakery, it is expected to save over 12,000 GJ/year. The bread baking system was of USA development and initial teething problems adapting to the more dense UK bread have now been overcome. (U.K.).

32100 **(EEO—62/94) Flux degasser on an aluminium bale-out furnace. A demonstration at Diecastings Ltd. [Birmingham].** (BNF Metals Technology Centre, Wantage (UK)). Sep 1985. 30p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751861.

A new method of cleaning and removing hydrogen from liquid aluminium has been adopted in a sand foundry at Diecastings Ltd. in Birmingham. The new process overcomes problems preventing the fast removal of hydrogen from the molten metal and reduces treatment time from 40 to 10 minutes. Holding temperatures have been lowered and the casting rejection rate has been reduced from 32% to 13%. For an initial outlay of pound 3,000, Diecastings Ltd. have realised cost savings of over pound 21,000/year from a reduced consumption of energy and materials. A simple payback period of less than two months has been achieved for the project. (author).

32101 **(EEO—64/116) Use of low thermal mass ceramic fibre linings on a bale-out furnace. Demonstration project at Fry's Diecastings Ltd. [Stourbridge].** (BNF Metals Technology Centre, Wantage (UK)). Oct 1985. 31p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751859.

A new type of bale-out furnace lining has been used at the Stourbridge plant of Fry's Diecastings Ltd. to reduce energy use in melting and holding liquid metal. The new lining consists of a low thermal mass liner moulded from ceramic fibre which fits inside the furnace shell and is backed by loose ceramic fibre. Energy consumption has been reduced and has resulted in cost savings of some pound 1,900/year for an initial capital and installation expenditure of pound 878. A simple payback period of just over 23 weeks has therefore been achieved for the project. By 1984, over 20 companies had successfully adopted this technology, and over 80 bale-out furnaces have had their energy efficiency performance improved as a result. (author).

32102 **(EEO—65/28) Space heating using waste heat recovered from a bale-out furnace. A demonstration at Brycast (Light Alloys) Ltd. [Wolverhampton].** (British Steel Corp., Rotherham. Swinden Labs.). Sep 1985. 36p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751857.

A scheme is described for space heating the main working area in a foundry using recovered heat from the waste gases produced by smelting furnaces. The air to be heated is drawn from outside the building and passed over the heat exchanger before being ducted into the foundry by a distribution fan. The waste heat recovered is 0.35 GJ hr implying a recovery efficiency of about 39% and a payback period of 1.5 years. Replication in the UK could potentially save 3,700TJ per annum. (U.K.).

32103 **(EEO—66/115) High efficiency electric radiant holding furnaces on diecasting machines. Demonstration project at Fry's Diecastings Ltd. [London].** (BNF Metals Technology Centre, Wantage (UK)). Oct 1985. 38p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751860.

Savings of over pound 19,000, in direct fuel costs, were achieved at the London foundry of Fry's Diecastings Limited in the first year following the replacement of eight conventional crucible holding furnaces by electric radiant units. In addition, the total cost of replacement parts was reduced by an estimated pound 6,000 pa, to give total savings of over pound 25,000 pa. This represents a payback of 2.5 years on the company's investment. The gross energy saving in the first year of operation was 7,290 GJ equivalent to an 83% reduction in energy use. It is considered that these figures would be typical of other sites in the pressure diecasting sector where similar furnaces are operated for 1,500 production hours per year. (author).

32104 **(EEO—67/136) Trials for a gas-fired immersion-heated holding furnace.** (BNF Metals Technology Centre, Wantage (UK)). Oct 1985. 35p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751862.

Commercial trials in 4 different foundries have shown that a new type of furnace can achieve up to 80% savings compared with the types of furnace commonly used in the melting and holding of liquid aluminium and its alloys. The new furnace is the gas fired immersion heated type and uses the self-recuperative burner developed by the Midlands Research Station of British Gas. The current (1985) cost is pound 8,000 and the payback at one foundry was under 1 year. In addition to the reduced energy consumption, additional benefits include cooler and quieter working conditions and longer retention times after sodium and strontium modification treatments. Thirty similar units have now been installed outside the UK. (U.K.).

32105 **(EEO—69/85/195) Rebuilding a paper machine press part to give increased water removal with control of moisture profile. A demonstration project at the Aylesford Mill of Reed Paper and Board (UK) Ltd. [Maidstone].** (PIRA, Leatherhead (UK)). Sep 1985. 92p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86751856.

The press part of a 1958 newsprint machine has been rebuilt using two Nipco rolls. This has permitted additional reduction of the water content with consequent 37% saving in the drying steam and a 8% reduction in power because the machine can run faster. As a result the 1958 newsprint machine is competitive with modern machines and simple payback on energy costs alone was 3.1 years. In addition, the output for fixed costs and manning levels has increased so that when the value of the additional output is added to the energy savings, the payback period is reduced to 9 months. (U.K.).

32106 **(EPRI-EM—3868-Vol.2) Evaluation of dual energy use systems (DEUS); distillation applications. Volume 2. Utility handbook. Final report.** Smith, E.O.; Gray, D.C. (Black and Veatch, Kansas City, MO (USA)). Apr 1986. 47p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920276.

This is Volume 2, Utility Handbook, of a three volume set on Evaluation of Dual Energy Use Systems (DEUS) Cogeneration Installations. Volume 1 is an Executive Summary, and Volume 3 is Case Studies. This Handbook is configured as a reference for persons interested in evaluating the feasibility of cogeneration. The Handbook highlights technical, institutional, and economic issues pertinent to cogeneration and outlines a methodology for incorporating those considerations in a feasibility analysis. Its emphasis is on factors to consider, critical assumptions, and an approach to cogeneration project feasibility analysis utilizing user-supplied data rather than on presenting a catalog of cost and performance information. To further assist the prospective cogenerator, worksheets to guide the analysis process and an example problem are provided.

32107 **(PB—86-168705/XAB) Evaluation of selected energy-recovery systems. Working paper.** Desai, T.M.; Salama, S.Y.; Kothari, V.S. (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). 28 Feb 1983. 50p. NTIS, PC A03/MF A01.

The purpose of the paper is to document key inputs and results of work performed in the area of Energy Recovery Systems (ERS) in support of the Industrial Utilization (IU) staff. This support consisted of the following four main activities: Integration and validation of technology performance and cost data generated by technology developers under contract with GRI; Developing characteristics of the industrial test markets and refining the representation of these markets when needed, e.g., segmentation of certain markets into more-detailed unit size categories or further characterization of competing process; Evaluation and analysis of future market potentials for each ERS in all applicable markets; and Projecting the total impacts of these ERS on energy and gas demand.

32108 **(PB—86-168713/XAB) Market impact of glass batch preheaters. Working paper.** Lerner, M.O.; Kothari, V.S.; Desai, T.M. (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). 15 Nov 1982. 39p. NTIS, PC A03/MF A01.

The objective of the study was to revise and update previously reported estimates of the market potential of the glass batch preheater under development by GRI. The approach and methodology is essentially the same as that used in the previous analysis. The major changes between this study and earlier reports are: this report uses new estimates of preheater costs; this report uses a different set of assumptions on future projections of industrial growth rates and fuel-price trends; and this analysis uses an improved methodology to simulate the impact of electric boosting. This change is a more-realistic reflection of the way boosting is being used by the glass industry to increase production.

32109 **(PB—86-168739/XAB) Electricity versus natural gas in small industrial boilers. Working paper.** Coleman, R.D. (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). 10 Aug 1982. 19p. NTIS, PC A02/MF A01.

Natural gas is currently the dominant fuel in the small industrial boilers market. The report compares the economics of small gas-fired industrial boilers with boilers that generate steam using electricity. Using the total costs of owning and operating each type of boiler as the basis for comparison, the report concludes that, given expected future fuel prices, no significant economic competition is expected from electric boilers.

32110 **Industrial heat pumps - types and costs.** Chappell, R.N.; Bliem, C.J. Jr.; Mills, J.I.; Demuth, O.J.; Plaster, D.S. (Dept. of Energy, Idaho Falls, ID). *Energy Technology (Washington, D.C.);* **12**: 1727-1735(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Confusion about energy savings and economics is preventing many potentially beneficial applications for industrial heat pumps. The variety of heat pumps available and the lack of a standard rating system cause some of this confusion. The authors illustrate how a simple categorization based on coefficient of performance (COP) can compare the cost of recovering waste energy with heat pumps. After evaluating examples in which the cost of energy delivered was calculated based on estimates of capital cost, operating costs, and maintenance costs, they compare heat pumps from the various categories on the basis of economics. 6 references, 6 figures, 1 table.

32111 **Recent trends in industrial electrification.** Burwell, C.G. (Oak Ridge Associated Universities, TN). *Energy Technology (Washington, D.C.);* **12**: 434-442(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

An examination of the historical trends in the electrification of 20 Standard Industrial Classification (SIC) groups divides them into labor- and energy-intensive categories. The two categories divide into machine-type and process-type operations, with further divisions based on the amount of energy used and degree of electrification. The findings show that the use of electricity per unit of output for manufacturing operations already highly electrified for mechanical functions will experience little change, but that electricity is being used increasingly to melt steel and glass, in cement manufacture, and in the pulp and paper industry. The large potential for further electrification is among energy-intensive process groups, such as organic chemicals and plastics. 4 references, 1 figure, 3 tables.

32112 **Status report on DOE's coal-water mixtures program.** McCann, C.R.; Kurtzrock, R.C.; Carabetta, R.A. (Dept. of Energy, Pittsburgh, PA). *Energy Technology (Washington, D.C.);* **12**: 1206-1214(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The DOE is pursuing both near- and long-term approaches to displacing petroleum fuels with coal for boiler and furnace use. The DOE/Pittsburgh Energy Technology Center program is evaluating the handling and combustion characteristics of coal-based fuels, determining pollutant emissions resulting from combustion of these fuels, and developing retrofit technology. The initial focus is on coal-water mixtures (CWM). The authors describe the program and conclude that the use of CWM in oil-designed utility boilers has a demonstrated technical feasibility. Commercialization of the technology is under pursuit in the industrial sector, and attention will be redirected to evaluate the application of CWM to smaller combustion systems and, ultimately, residential heating systems. 7 references, 1 figure.

32113 **Developing an industrial boiler inventory.** Wilson, J.H. Jr.; Pechan, E.H.; Rothschild, S.S. (E.H. Pechan & Assoc., Inc., Springfield, VA). *Proceedings, Annual Meeting, Air Pollution Control Association;* **6**: 16(1984). (CONF-840612—).

From Air Pollution Control Association annual meeting; San Francisco, CA, USA (25 Jun 1984).

Identifying major sources of sulfur and nitrogen oxides and evaluating the cost effectiveness of various control techniques has been of concern in acid rain research in the United States for the past five years. Although the electric utility industry has been the major focus of previous efforts in assessing SO/sub x/ and NO/sub x/ emissions and the effects of control strategies, as utility emissions become well-controlled, industrial sources will contribute a larger share to the total pollutant burden and will become of more concern. This study seeks to establish an applicable and available industrial boiler data base for use in acid rain analysis. There is no single data base that can satisfy all the needs for industrial boiler emissions estimation and fuel choice modeling. The purpose of this study, therefore, is to determine if there is a way to combine available sources of industrial boiler data to produce a statistically acceptable data source. The objective is to characterize the industrial boiler population by size, capacity utilization, fuel type, capability to burn alternative fuels, industry, fuel consumption, state and air quality control region (ACQR) location, and emissions control equipment for all boilers with a capacity of 10 mmrtu/hour or larger.

3206 Municipalities And Community Systems

REFER ALSO TO CITATION(S) 31782, 31965, 32004

32114 (CONF-850241—, pp 71-75) **Microcomputer software requirements of local government energy management programs and projects.** Winger, H.; Gallaher, S.L.; Herkert, J.R. (Office of Energy Management, St. Louis, MO). May 1985. NTIS, PC A16. File Number DE86007106.

From 1. national conference on microcomputer applications for conservation and renewable energy; Tucson, AZ, USA (26 Feb 1985).

The role of microcomputers in contributing to the mission of local government energy management programs and projects is discussed. The historical background of such programs is discussed, as well as the requirements and constraints confronting local government energy managers with respect to the use of microcomputers. Results are summarized of a review of commercially and publicly available software packages for use with energy management activities. Also presented are preliminary findings of a survey of local government energy managers designed to determine the extent to which such users are currently making use of microcomputer hardware and commercially or publicly available software. In addition, the information requirements of such users with respect to microcomputer applications are considered.

32115 **Utility's decision to establish an energy services subsidiary.** Weedall, M. (Bonneville Power Administration, Portland, OR). *Energy Technology (Washington, D.C.);* **12**: 835-847(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

A survey of 30 utilities found a growing trend for public utilities to diversify beyond their traditional services. The author examines one area of diversification: the establishment of an energy service company as a separate subsidiary outside the regulated

arena. He defines energy services to include auditing, installation, operations, maintenance, and financing on a turnkey basis, but does not cover cogeneration activities. The utilities justify this activity on the basis of business opportunities, customer service and response to private competition, utility skills and opportunity for employees, the need for load shaping, and regulatory push. Utilities which decide not to diversify cite the lack of appropriate skills or adequate return and regulation among their reasons. Other utilities adopted joint venture guarantee savings, or purchase energy savings as alternatives to diversification. 3 tables.

32116 **Designing and developing a DHC system in Provo, Utah.** Limburg, G.S. (Provo City Dept. of Energy Services, UT). *Energy Technology (Washington, D.C.);* **12**: 940-949(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

DOE-sponsored research on district heating and cooling in Provo, Utah demonstrates the potential for conserving energy and improving urban air quality. Customers will benefit from stabilized energy prices, decreased dependence on scarce fuels, potential for integration of municipal waste energy recovery, and economic stimulus due to construction and growth in district heated/cooled areas. An economic analysis of the Provo project showing a net revenue gain for the city indicates economic feasibility and financial viability. 1 table.

3209 Education And Public Relations

32117 **Microcomputer software for energy conservation investment analysis.** Reid, M.W. (Alliance to Save Energy, Washington, DC). *Energy Technology (Washington, D.C.);* **12**: 958-965(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The Washington-based Alliance to Save Energy has focused its projects on barriers that inhibit investment in energy efficiency measures that are known to be cost-effective. A 1983 study suggested that financial analysis is often the weak link in companies' investment programs because they do no convincingly demonstrate that the proposed investment is cost-effective and will offer a competitive or superior rate of return. A computerized approach using a software package to help energy managers was developed following a series of case studies of potential software users. The software assists in calculations, sensitivity testing of statistics, comparisons, database management, and data analyses. The ENVEST program is menu-driven, with full-screen data entry and editing and other features to help the user. The program also analyses financing and payback options.

33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

REFER ALSO TO CITATION(S) 32014

32118 **(DOE/RL/01830—H1) Analysis of the capabilities of domestic auto-manufacturers to improve corporate average fuel economy (information current as of November 1985).** (Energy and Environmental Analysis, Inc., Arlington, VA (USA)). Apr 1986. Contract AC06-76RL01830. 104p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86010055.

Since 1978, the Department of Energy (DOE) has conducted periodic reviews of the ability of domestic automobile manufacturers to improve their corporate average fuel economy (CAFE) values. This work has allowed DOE to develop a detailed understanding of manufacturer technological capabilities and to forecast the cost, fuel economy improvement, and rate of introduction of individual technologies over a ten-year horizon. DOE uses these forecasts to fulfill its responsibilities under the Energy Policy and Conservation Act (EPCA), to support its forecasts of energy demand and to conduct policy analyses relevant to automobile and energy production industries. Chapters are given for the following areas: (1) review of 1985 CAFE, (2) analysis of current capabilities, (3) modifications of the Technology Cost Segment Model (TCSM), (4) review of market share forecasts, and (5) forecasts of CAFE using the TCSM.

32119 **Transportation Energy Research.** Whitson, M.O. (ed.). (Dept. of Energy, Office of Scientific and Technical Information, Oak Ridge, TN). *Transportation Energy Research;* 16(15 Jan 1986). (PB—86-900901).

Available from National Technical Information Service, Springfield, VA 22161 on a subscription basis at $45.00 per volume (calendar year).

This abstract bulletin announces on a semimonthly basis the current worldwide information available on the engineering and design of energy-efficient advanced automotive propulsion systems and all aspects of energy conservation measures involving transportation.

3301 Internal Combustion Engines

REFER ALSO TO CITATION(S) 31417, 32132, 32146, 32147, 32149, 32150

32120 **Combustion effects on the preflame flow field in a research engine.** Witze, P.O.; Borganakke, C. Warrendale, PA; Society of Automotive Engineers, Inc. (1985). 13p. (TP—850122). Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

Measurements are presented for the turbulence intensities and mean velocities obtained in a research engine in which a grid was used to create a flow field characterized by negligible mean motions and homogeneous and isotropic turbulence at the time of ignition. Pressure measurements for homogeneous stoichiometric combustion indicate a very low level of cyclic variation. The combustion-induced mean flow field is shown to be characteristic of a one-dimensional compression of the unburned gases, which produces a small increase in the bulk turbulent kinetic energy ahead of the flame. Most of the effect of combustion appears to occur locally, as the turbulence in the preflame gases close to the flame front is strongly amplified in the direction of flame propagation. Parallel to the flame surface there is little effect until the flame has propagated nearly all the way across the chamber.

32121 **On the intact core of full-cone sprays.** Chehroudi, B.; Chen, S.H.; Bracco, F.V.; Onuma, Y. Research Triangle Park, NC; Instrument Society of America (1985). 10p. (TP—850126). Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096. Contract AC04-81AL16338.

A voltage was applied between the nozzle unit and fine needles, rods, and screens inserted at various axial and radial positions into atomizing full-cone water sprays and the corresponding electrical resistance was measured in an attempt to determine the shape and length of the intact liquid core. The parameters of the experiment were: room temperature; air compressed at 0.1, 1.0, and 2.9 MPa; injection $\Delta p = 13.7$ MPa; and five straight-hole nozzles with diameters of 127, 178, 305, 343, and 508 μm, and the same length-to-diameter ratio of 4. The results show that current is carried not only by intact liquid cores but also by atomized unconnected sprays and even across such sprays. Thus the shape of the intact core could be deduced only in the vicinity of the nozzle exit. In the atomization regime, the length of the intact core is found to be proportional to the nozzle diameter and to increase as the square root of the liquid-to-gas density ratio, i.e. $x_1 = \text{Rhod}(\text{p/sub lpg/})^{12}$ where $\text{Rho} \approx 7$.

32122 **A photographic study of plasma ignition systems.** Edwards, C.F.; Stewart, H.E.; Oppenheim, A.K. Warrendale, PA; Society of Automotive Engineers, Inc. (1985). 10p. (TP—85077). Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096. Contract AC03-76SF00098.

A photographic study was conducted using an optical-access compression-expansion machine in order to reveal the mechanism of ignition and flame propagation initiated by plasma igniters. The tests included a jet igniter with inert cavity liner (quartz), a jet igniter with reactive cavity liner (paraffin), and a J-gap spark plug. Schlieren cinematographic records were obtained for each condition along with concomitant pressure traces. Basic features of ignition and combustion at lean limit were determined for each igniter.

The spark plug permited lean operation down to an equivalence ratio of 0.7, after which mis-ignition occurred. Jet igniters provided an extension of lean limit to 0.5 in equivalence ratio. For jet igniters, these limits were imposed by either extinction of the flame or too slow burning rate, rather than by misfire.

32123 **Three-dimensional flow field in four-stroke model engines.** Arcoumanis, C.; Bicen, A.F.; Vafidis, C.; Whitelaw, J.H. Warrendale, PA; Society of Automotive Engineers, Inc. (1984). 10p. (SAE-TP—841360).

Ensemble-averaged and in-cycle axial and swirl velocities have been measured by laser Doppler anemometry in the three-dimensional flow field of a four-stroke model engine motored at 200 rpm with a compression ratio of 6.7 and various cylinder head and piston geometries. The inlet configurations comprised an axisymmetric port with a shrouded valve and an off-centre port with two valve and swirl generating vane geometries. The piston configurations comprised flat, cylindrical and re-entrant axisymmetric pistonbowls. The results indicate that with the off-centre port a complex vortical flow pattern is generated during induction, which later either collapses in the absence of induction swirl or is transformed into a single rotating vortex in the transverse plane when swirl is present. The axisymmetric port with the shrouded valve gives rise to a double vortex structure and higher turbulence levels at TDC of compression compared to the off-centre port. The in-cycle swirl velocities indicate that the swirl centre oscillates during the compression stroke in phase, on the average, with the piston motion with associated turbulent fluctuations of smaller magnitude than the cycle-to-cycle velocity variations.

32124 **Engine wear with methanol fuel in a nitrogen-free environment.** Naegeli, D.W.; Yost, D.M.; Owens, E.C. Warrendale, PA; Society of Automotive Engineers, Inc. (1984). 10p. (SAE-TP—841374).

Several test programs have shown that the combustion of methanol in spark ignition engines can cause unusually high corrosive wear of the upper cylinder bore and ring areas. A 2.3-liter engine fueled with methanol was operated in a nitrogen-free atmosphere to determine the importance of nitric acid in the corrosion mechanism. A 20-hour steady-state test was carried out using neat methanol as the fuel and a mixture of oxygen, argon, and carbon dioxide in place of air. Only trace amounts of NO/sub x/ and nitric acid were found in the exhaust products during this test. The wear, indicated by iron buildup in the lubricant, was found to be essentially the same in the nitrogen-free test as that detected in baseline engine tests combusting methanol-air mixtures. It was concluded that nitric acid does not play a role in the corrosion mechanism.

32125 **An investigation of the issues surrounding the fuels adaptability of the advanced gas turbine.** Rentz, R.L.; McCallum, P.W.; Moore, J.S.; Timbario, T.J.; Alpaugh, R.T. Warrendale, PA; Society of Automotive Engineers, Inc. (1984). 13p. (SAE-TP—841362).

Advanced gas turbine (AGT) engines may exhibit widened fuel tolerance as well as improved thermal efficiency relative to current spark-ignition engines. However, the inherent adaptability of the engine to a variety of fuels may not be reflected in the practical fuels adaptability of gas turbine engine vehicles which are acceptable from commercial and regulatory perspectives. Results are presented of a study of the primary issues surrounding the fuels adaptability of commercial AGT vehicles. Topics addressed include candidate fuels and fuel characteristics, and AGT combustion and fuel system characteristics. Results of an analysis of relationships between engine characteristics and fuel properties are presented as well as observations concerning future research.

3303 Electric-powered Systems

REFER ALSO TO CITATION(S) 31967

32126 **(LA-UR—86-1476) Progress in fuel cells for transportation applications.** Murray, H.S. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 20p. (CONF-8605109—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010206.

From 3. international symposium on hydrogen produced from renewable energy; Manoa, HI, USA (22 May 1986).

The current and projected states of development of fuel cells are described in terms of availability, performance, and cost. The applicability of various fuel cell types to the transportation application is discussed, and projections of power densities, weights, and volumes of fuel cell systems are made into the early 1990s. Research currently being done to advance fuel cells for vehicular application is described. A summary of near-term design parameters for a fuel cell transit line is given, including bus performance requirements, fuel cell power plant configuration, and battery peaking requirements. The objective of this paper is to determine a fuel cell technology suitable for near-term use as a vehicular power plant. The emphasis of the study is on indirect methanol fuel cell systems.

32127 **Update on the Electric Vehicle Development Corporation.** Mader, G.H.; High, M.D. *Energy Technology (Washington, D.C.);* **12**: 776-785(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The Electric Vehicle Development Corp. (EVDC) sees its role as one of charting and pursuing a realistic course for EV commercialization in the US. The company has developed a step-by-step approach for introducing EVs into commercial fleets in the late 1980s and the transportation market in the early 1990s. The company concentrated during the first year on characterizing the market and developing specifications that can capture the largest market segment and expand its base. Consultants and joint DOE/Electric Power Research Institute projects have strengthened contacts and made the company better able to coordinate the overall effort. 4 figures.

32128 **Integration and system tests of the Ford/General Electric ac electric drive system.** King, R.D.; Park, J.N. Warrendale, PA; Society of Automotive Engineers, Inc. (1985). 7p. (TP—850199). Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

An advanced alternating current electric drive system is being developed by the General Electric Company for Ford Motor Company's "Advanced Electric Vehicle Powertrain Effort," which is a major element of DOE's Single Shaft Electric Propulsion System Program. The integrated transaxle consists of an oil-cooled 50 hp ac induction motor mounted within a 2-speed transaxle. Direct current from the nominal 204 V battery pack is converted to variable frequency, variable voltage 3-phase ac current by a liquid-cooled transistor inverter. A custom-designed inverter motor controller, containing two 8751 microcomputers plus analog and digital circuitry, translates torque commands from the controller to the inverter transistor base drivers that turn on/off power Darlington transistors at appropriate times. After a review of the electric drive system ratings, details of the transistor inverter are presented. Control strategy and controller design are summarized. Electric drive integration and system test results are given.

32129 **Advanced ac powertrain for electric vehicles.** Slicker, J.M.; Kalns, L. Warrendale, PA; Society of Automotive Engineers, Inc. (1985). 18p. (TP—850200). Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

The design of an ac propulsion system for an electric vehicle includes a three-phase induction motor, transistorized PWM inverter/battery charger, microprocessor-based controller, and two-speed automatic transaxle. This system was built and installed in a Mercury Lynx test bed vehicle as part of a Department of Energy propulsion system development program. An integral part of the inverter is a 4-kw battery charger which utilizes one of the bridge transistors. The overall inverter strategy for this configuration is discussed. The function of the microprocessor-based controller is described. Typical test results of the total vehicle and each of its major components are given, including system efficiencies and test track performance results.

32130 **Development and testing of an electric farm tractor.** Christianson, L.L.; Alcock, R.; Froehlich, D.; Knabach, W.; Endahl, L. (South Dakota State Univ., Brookings). *Energy Technology (Washington, D.C.);* **12**: 766-775(1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The battery-powered tractor, Electric Choremaster I, designed, built, and tested at South Dakota State University, is an 80 hp, high-clearance vehicle intended for all-weather applications and for commercial and industrial applications which require a loader/backhoe. Electric Choremaster II is a skid-steer tractor of 40 hp for in-building work and commercial applications requiring compact size and sharp-turning capability. Following a review of the literature on electric vehicles, the authors describe the technology and design and the results of performance tests and cost comparisons. Design changes on the basis of these tests will improve life-cycle costs. 8 references, 3 figures, 3 tables.

3307 Emission Control

32131 **(EIR—581) Measurements of the emissions from stationary diesel engines used in total energy plants and heat pumps.** Koebel, M. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Nov 1985. 67p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752029.

The results of emission measurements of eight stationary diesel engines are presented. Four were installed in total energy plants and four in heat pumps. The measurements confirmed the high levels of pollutants emitted from internal combustion engines, especially of nitrogen oxides. With diesel engines, the type of fuel combustion has a marked influence on the NOsub(x) emission. Whereas engines with direct injection showed emissions in the range of 1400-1800 g NO_2/GJ (referred to fuel energy), the engines equipped with a precombustion chamber showed much lower values at 300-600 g NO_2/GJ. For comparison a typical oil fired boiler shows a NOsub(x) emission of only 40 g NO_2/GJ. A turbocharger increases the NOsub(x) output both with direct injection and with precombustion chamber engines. The emission of soot was found to lie in the range of 10-20 g/GJ (referred to fuel energy). This is about two to four times greater than typical emissions from an oil fired boiler (5 g/GJ). (orig./HW).

32132 **(NIPER—151) Vehicle evaporative and exhaust emissions as influenced by benzene content of gasoline. Final report.** Seizinger, D.E.; Marshall, W.F.; Cox, F.W.; Boyd, M.W. (National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)). Apr 1986. Contract FC22-83FE60149. 60p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010603.

To better define the effect of fuel composition on benzene emissions from current production vehicles, the evaporative and exhaust emissions from five current model vehicles equipped with representative emission control systems were studied. Fuels consisting of two aromatic levels and four benzene concentrations were tested in the above vehicles. Benzene and regulated emissions were measured in each test segment. Benzene content and the detailed hydrocarbon (HC) compositions of the fuels were also measured. In addition to the evaporative and exhaust emissions, engine-out and tailpipe-out emissions were measured simultaneously as a means of assessing the on-board catalyst conversion efficiency of benzene. Conclusions are as follows: Head space, evaporative and exhaust emission results reported as benzene, wt % in HC, increase linearly with increasing fuel benzene. Measurable benzene evaporative emissions occurred with benzene-free fuel due to desorption of benzene captured by the canister from previous test fuels. Benzene exhaust emissions occurred with benzene-free fuel due to production of benzene from precursors in the combustion process. Total vehicular benzene emission rates increased about 4 mg/mile for an increase of 1 vol % fuel benzene. Exhaust benzene emission rates increased by about 4 mg/mile for 15 vol % fuel aromatic differential. Vehicular sources of benzene emissions averaged about 70% exhaust, 20% evaporative, and 10% refueling for 1.5 vol % benzene fuel. Catalyst conversion efficiency results showed benzene conversion ranged from 74 to 95% and HC conversion ranged from 82 to 91% over the five vehicles. The evaporative benzene carry-over study showed that evaporative benzene emissions are directly affected by the composition of prior test fuels for as many as three prior tests.

32133 **(PB—86-135795/XAB) Application for certification, 1986 model year light-duty vehicles - Alfa Romeo.** (Alfa Romeo, Inc., Englewood Cliffs, NJ (USA)). 1985. 305p. NTIS, PC A14/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32134 **(PB—86-135803/XAB) Application for certification 1986 model year light-duty vehicles - BMW.** (BMW of North America, Inc., Montvale, NJ (USA)). 1985. 349p. NTIS, PC A15/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32135 **(PB—86-135829/XAB) Application for certification 1986 model year light-duty vehicles - General Motors.** (General Motors Proving Ground, Milford, MI (USA)). 1985. 2067p. NTIS, PC A99/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32136 **(PB—86-135837/XAB) Application for certification, 1986 model year light-duty vehicles - Honda.** (American Honda Motor Co., Inc., Gardena, CA). 1985. 459p. NTIS, PC A17/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition

systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32137 **(PB—86-135845/XAB) Application for certification, 1986 model year light-duty vehicles - Isuzu.** (Isuzu Motors America, Inc., Southfield, MI). 1985. 2602p. NTIS, PC A99/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32138 **(PB—86-135852/XAB) Application for certification, 1986 model year light-duty vehicles - Jaguar.** (Jaguar Rover Triumph, Inc., Leonia, NJ (USA)). 1985. 131p. NTIS, PC A09/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32139 **(PB—86-135860/XAB) Application for certification, 1986 model year light-duty vehicles - Mazda.** (Mazda (North America), Inc., Farmington Hills, MI (USA)). 1985. 697p. NTIS, PC A20/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32140 **(PB—86-135878/XAB) Application for certification, 1986 model year light-duty vehicles - Mitsubishi.** (Mitsubishi Motors Corp., Tokyo (Japan)). 1985. 467p. NTIS, PC A18/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32141 **(PB—86-135886/XAB) Application for certification, 1986 model year light-duty vehicles - Nissan.** (Nissan Motor Co. Ltd., Yokohama (Japan)). 1985. 2696p. NTIS, PC A99/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32142 **(PB—86-135902/XAB) Application for certification, 1986 model year light-duty vehicles - Rolls Royce.** (Rolls Royce Motors, Inc., Lyndhurst, NJ (USA)). 1985. 340p. NTIS, PC A15/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32143 **(PB—86-135910/XAB) Application for certification, 1986 model year light-duty vehicles - Volkswagen/Audi.** (Volkswagen of America, Inc., Ann Arbor, MI). 1985. 3091p. NTIS, PC A99/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32144 (PB—86-135928/XAB) Application for certification, 1986 model year heavy-duty vehicles - General Motors Corporation. (General Motors Proving Ground, Milford, MI (USA)). 1985. 315p. NTIS, PC A14/MF A01.

Every year, each manufacturer of passenger cars, light-duty trucks, motorcycles, or heavy-duty engines submits to EPA an application for certification. In the application, the manufacturer gives a detailed technical description of the vehicles or engines he intends to market during the upcoming model year. These engineering data include explanations and/or drawings which describe engine/vehicle parameters such as basic engine design, fuel systems, ignition systems and exhaust and evaporative emission control systems. It also provides information on emission test procedures, service accumulation procedures, fuels to be used, and proposed maintenance requirements to be followed during testing. Section 16 of the application contains the results of emission testing, a statement of compliance to the regulations, production engine parameters, and a Summary Sheet Input Form on which issuance of a Certificate of Conformity is based.

32145 (PB—86-155611/XAB) Inspection and maintenance of new-technology vehicles in Washington, DC. Technical report. Adler, J. (Environmental Protection Agency, Ann Arbor, MI (USA). Technical Support Staff). Jul 1985. 39p. NTIS, PC A03/MF A01.

The report presents the results of an emission-testing program conducted for EPA in Washington, D.C., under contract. In the test program, 1980 and 1981 model-year vehicles that failed the Inspection and Maintenance (I/M) test in Washington, D.C. were given two or three series of emissions tests. Each series included a Federal Test Procedure (FTP), a Highway Fuel Economy Test, and the following short tests: 50 mph cruise, four-mode idle, engine restart idle, and loaded two-mode. In June, 1984, EPA became aware of some quality-control problems which were evident at the D.C. inspection stations. These problems may have caused some of the vehicles which were participating in the project to be inappropriately failed during the initial inspection or inappropriately passed during the reinspection. Analyses described in the report evaluate the decisions made by the inspection lane, and compare the effects of I/M on the whole group of cars with those of subgroups that have had suspect cases removed.

32146 (PB—86-155819/XAB) Environmental assessment of NOx control on a compression-ignition large-bore reciprocating internal-combustion engine. Volume 1. Technical results. Final report, April 1980-April 1981. Castaldini, C. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Jan 1986. 113p. (ACUREX/TR—81-81/EE). NTIS, PC A06/MF A01.

Volume I of the report gives emission results from field tests of the exhaust gas from a large-bore, compression-ignition reciprocating engine burning diesel fuel. An objective of the tests was to evaluate the operating efficiency of the engine with combustion modification NOx control to reduce emissions to below the proposed NOx new source performance standard (NSPS) of 600 ppm at 15% O_2 dry. Engine NOx emissions were reduced 31 percent (from 825 to 571 ppm) at 15% O_2 with 3.5 degrees of fuel injection timing retard. The reduction was accompanied by a 1% loss in engine efficiency. CO emissions decreased slightly (from 119 to 90 ppm). Total unburned hydrocarbons remained relatively unchanged (25 ppm), as did particulate emissions (35 ng/J) and total organic emissions (55 ng/J). Volatile organics (boiling point less than about 100 C) accounted for the largest fraction of the total organic. Naphthalene, fluoroanthene, phenanthrene/anthracene, and pyrene were the only organic priority pollutants detected in both tests at levels below 70 micrograms/dscm.

32147 (PB—86-155827/XAB) Environmental assessment of NOx control on a compression ignition large-bore reciprocating internal-combustion engine. Volume 2. Data supplement. Final report, April 1980-April 1981. Castaldini, C. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Jan 1986. 174p. (ACUREX/TR—81-81/EE). NTIS, PC A08/MF A01.

Volume II of the report is a compendium of detailed emission and test data from field tests of a large-bore, compression-ignition reciprocating engine burning diesel fuel. The engine was tested during two operating modes: at baseline (normal operation), and with fuel-injection retard for NOx emission reduction to levels below the proposed new source performance standard (NSPS) for such engines. The test data include preliminary equipment calibration, detailed engine operation, and complete exhaust gas emission measurement results. Exhaust gas emission measurements included (in addition to continuous monitoring for criteria gas pollutants) monitoring for volatile hydrocarbons (C1-C6), particulates, sulfur oxides, total organics in two boiling point ranges, organic compounds, semivolatile organic priority pollutants, trace elements, and biological assays of organic sample extracts.

32148 (PB—86-156593/XAB) In-use evaporative canister evaluation. Final report, December 1984-June 1985. Warner-Selph, M.A. (Southwest Research Inst., San Antonio, TX (USA)). Dec 1985. 105p. NTIS, PC A06/MF A01.

The program involved the evaluation of 24 samples of charcoal from in-use evaporative canisters. The Environmental Protection Agency (EPA) provided the canisters from programs conducted by the EPA, Tennessee Valley Authority (TVA), and Southwest Research Institute (SwRI) on both alcohol blend-fueled and unleaded gasoline-fueled vehicles. Ten canisters from alcohol blend-fueled vehicles, eight from gasoline-fueled vehicles, and six from vehicles with unknown fuel histories were tested. A system was developed to remove and collect the effluent from samples of canister charcoal at room temperature (cold purge) and under heated conditions (hot purge). Charcoal samples of about 50 g were first cold purged with dry nitrogen at a flowrate of approximately 1.5 cfm. Butane working capacity was then measured, and the charcoal was subsequently hot purged at approximately 355-375 F (180-190 C). The effluent was sampled during selected cold and hot purge cycles and analyzed for water content, methanol, ethanol, tertiary butyl alcohol (TBA), total hydrocarbons (THC), and selected detailed hydrocarbons.

32149 (PB—86-156809/XAB) Environmental assessment of NOx control on a spark-ignited large bore reciprocating internal combustion engine. Volume 1. Technical results. Final report, April 1980-June 1981. Castaldini, C. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Jan 1986. 112p. (ACUREX/TR—81-79/EE). NTIS, PC A06/MF A01.

Volume I of the report gives emission results for a spark-ignited, largebore, reciprocating, internal-combustion engine operating both under baseline (normal) conditions, and with combustion modification controls to reduce NOx emissions to levels below the proposed new source performance standard (NSPS) for such engines. Exhaust-gas measurements includan addition to continuous monitoring of criteria gas emissions) total organics in two boiling point ranges, compound category information within these ranges, specific quantitation of semivolatile organic priority pollutants, fluegas concentrations of 73 trace elements, and particulates. Exhaust NOx emissions were reduced almost 50%, from a baseline level of 1260 ng/J (730 to 420 ppm corrected to 15% O_2 dry) by increasing the operating air /fuel ratio of the engine. Accompanying the reduction was a slight increase in engine efficiency. CO, methane, total hydrocarbon, and total semivolatile organic compound emissions were increased from 10 to 65% under low-NOx operation. However, total nonvolatile organic emissions decreased 55%. The organic emissions for both tests consisted primarily of aliphatic hydrocarbons with some carboxylic acids, phenols, and low-molecular-weight fused-ring aromatics. POMs were detected in concentrations below 4 micrograms/dscm.

32150 (PB—86-156817/XAB) Environmental assessment of NOx control on a spark-ignited large bore reciprocating internal combustion engine. Volume 2. Data supplement. Final report, April 1980-June 1981. Castaldini, C. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Jan 1986. 159p. (ACUREX/TR—81-79/EE). NTIS, PC A08/MF A01.

Volume II of the report is a compendium of detailed emission and test data from field tests of a large-bore, spark-ignited reciprocating engine and laboratory analyses of collected samples.

The engine was tested in two operating modes: a baseline (normal) operation, and with increased air/fuel ratio for NOx reduction to levels below the proposed new source performance standard (NSPS) of 700 ppm dry at 15% O2. The test data include preliminary equipment calibration, detailed engine operation, and complete exhaust gas emission measurement results. Exhaust-gas emission measurements included (in addition to continuous monitoring for criteria gas pollutants) monitoring for volatile hydrocarbons (C1-C6), total organics in two boiling point ranges, organic compound category information, specific quantitation of the semivolatile organic priority pollutants, separation of organic extracts, exhaust gas concentration of trace elements, and biological assays of organic sample extracts.

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REFER ALSO TO CITATION(S) 32124, 32125

32151 **State of knowledge of environmental concerns related to natural-gas-fueled vehicles.** Singh, M.K.; Moses, D.O. (Argonne National Lab., IL). *Energy Technology (Washington, D.C.);* **12**: 786-792(Aug 1985).

The potential for growth of natural gas vehicles (NGVs) and their different performance, emission, and safety characteristics prompted a DOE-sponsored study to document environmental concerns. The authors describe the vehicle technology and fueling system, then summarize the major findings of the study, which also examined regulatory considerations in the sale and use of np. NTIS, PC A02/MF A01.

Both the dc electrical resistivity and the attenuation of surface acoustic waves (SAW) were measured in the superconducting state of a granular lead film, as a function of a perpendicular magnetic field. At 4.2 K the film appears to have an upper critical field of about 60 kG. Bulk ultrasonic measurements were in the series $Er(1-x)Ho(x)Rh_4B_4$. At 15 MHz, a broad peak in attenuation, due to a relaxation mechanism associated with the Ho ions, is observed around 10 K. It moves to lower temperatures as x is decreased. An increase in attenuation is observed in the superconducting state of those alloys which are ferromagnetic superconductors. This increase may be due to superconducting screening of crystalline-field effects that inhibit spin-phonon interaction in the normal state. Preliminary measurements of the acousto-electric coupling of SAW with an Al granular film, which is held 15 micron's above the SAW, indicate that at 19 MHz the attenuation increases when the film becomes superconducting. This is an unexpected result since at this frequency the attenuation is expected to decrease when the film becomes superconducting.

32155 **(AERE-G—3583) Stress corrosion cracking tests on electron beam welded carbon steel specimens in carbonate-bicarbonate solution.** Parkins, R.N. (UKAEA Atomic Energy Research Establishment, Harwell. Materials Development Div.). Apr 1985. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702012.

Stress corrosion cracking tests have been performed on tapered carbon steel test pieces containing electron beam welds with a view to defining susceptibility to such cracking in a carbonate-bicarbonate solution at 90°C and an appropriate electrode potential. The tests involved applying cyclic loads to the specimens and it is shown that the threshold stress for cracking reduces linearly with increase in the magnitude of the cyclic load component. Extrapolation of these trends to zero fluctuating stress indicates static load threshold stresses in the vicinity of the yield stress (i.e. about 300 N/mm^2 for parent plate without a weld, 400 N/mm^2 for specimens with welds on one side only and 600 N/mm^2 for specimens having welds penetrating through the thickness of the specimen). The averages of the maximum crack velocities observed were least for parent plate material and greatest for weld metal, the former being essentially intergranular in morphology and the latter mostly transgranular, with heat affected zone material being intermediate between these extremes.

32158 **(BMFT-FB-T—85-171) Determination of the energetic and technical most favourable method for removing hydrogen from slabs and plates.** Bergmann, B.; Kreutz, L.; Mueller, N.; Jungblut, H.A. (Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.)). Dec 1985. 55p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751999.

A mathematical model is developed which allows to calculate the diffusion of hydrogen in slabs and plates under consideration of a trapping zone. Having adapted the model with production trials the maximal allowable hydrogen contents of heats can be calculated quantitatively for each imaginable hydrogen removing treatment of slabs and plates. With these calculations it is possible to find out the measures causing in practice the most favourable removing method for hydrogen in respect to time and energy. (orig.). With 15 refs., 23 figs.

32157 **(CNEN-DR—130/85) Study about the structural behavior of WStE-36N steel.** Santos Pinto, M. dos; Trindade, M.B. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro. Dept. de Reatores). 1985. 89p. (In Portuguese). NTIS (US Sales Only), PC A05/MF A01. File Number DE86702011.

The influence of a stress relaxation heat treatment in welding done by submerged-arc-welding is studied. This influence was studied in a structural steel, WStE-36N, niobium alloy, made in Brazil, through Charpy V test, hardness measurements, micro-structural aspects and X-ray diffraction.

32158 **(CONF-860421—30) Microstructural evolution in an austenitic stainless steel fusion reactor first wall.** Stoller, R.E.; Odette, G.R. (Oak Ridge National Lab., TN (USA); California Univ., Santa Barbara (USA). Dept. of Chemical and Nuclear Engineering). 1986. Contract AC05-84OR21400;AS03-82ER52081. 30p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010395.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

A detailed rate-theory-based model of microstructural evolution under fast neutron irradiation has been developed. The prominent new aspect of this model is a treatment of dislocation evolution in which Frank faulted loops nucleate, grow and unfault to provide a source for network dislocations while the dislocation network can be simultaneously annihilated by a climb/glide process. The predictions of this model compare very favorably with the observed dose and temperature dependence of these key microstructural features over a broad range. This new description of dislocation evolution has been coupled with a previously developed model of cavity evolution and good agreement has been obtained between the predictions of the composite model and fast reactor swelling data as well. The results from the composite model also reveal that the various components of the irradiation-induced microstructure evolve in a highly coupled manner. The predictions of the composite model are more sensitive to parametric variations than more simple models. Hence, its value as a tool in data analysis and extrapolation is enhanced.

32159 **(CONF-860421—31) Modification of the grain boundary microstructure of the austenitic PCA stainless steel to improve helium embrittlement resistance.** Maziasz, P.J.; Braski, D.N. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010396.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Grain boundary MC precipitation was produced by a modified thermal-mechanical pretreatment in 25% cold worked (CW) austenitic prime candidate alloy (PCA) stainless steel prior to HFIR irradiation. Postirradiation tensile results and fracture analysis showed that the modified material (B3) resisted helium embrittlement better than either solution annealed (SA) or 25% CW PCA irradiated at 500 to 600°C to ~21 dpa and 1370 at. ppM He. PCA SA and 25% CW were not embrittled at 300 to 400°C. Grain boundary MC survives in PCA-B3 during HFIR irradiation at 500°C but dissolves at 600°C; it does not form in either SA or 25%

CW PCA during similar irradiation. The grain boundary MC appears to play an important role in the helium embrittlement resistance of PCA-B3.

32160 **(CONF-860421—32) Saturation of the DBTT shift of irradiated 12Cr-1MoVW with increasing fluence.** Vitek, J.M.; Corwin, W.R.; Klueh, R.L.; Hawthorne, J.R. (Oak Ridge National Lab., TN (USA); Materials Engineering Associates, Inc., Lanham, MD (USA)). 1986. Contract AC05-84OR21400. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010393.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Ferritic/martensitic steels are considered one of the prime candidate materials for structural applications in fusion reactors. This class of steel provides many advantages including excellent swelling resistance and high thermal conductivity. A reiew of current results on the suitability of ferritic/martensitic steels reveals their corrosion behavior and postirradiation properties are, in general, quite promising. However, a major concern is the existence in these steels of a ductile-to-brittle transition temperature (DBTT), below which the steel has limited ductility and fails in a brittle mode. Although the DBTT, as measured in a Charpy impact test, may be below room temperature in the unirradiated condition, irradiation can increase the DBTT significantly, and the increase depends on the irradiation temperature. Increases in the DBTT of greater than 100°C have been measured following irradiation at 400°C and below.

32161 **(CONF-860421—33) Complementary AES and AEM of grain boundary regions in irradiated γ′-strengthened alloys.** Farrell, K.; Kishimoto, N.; Clausing, R.E.; Heatherly, L.; Lehman, G.L. (Oak Ridge National Lab., TN (USA); National Research Inst. for Metals, Sakura, Ibaraki (Japan). Tsukuba Lab.). 1986. Contract AC05-84OR21400. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010397.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Two microchemical analysis techniques are used to measure solute segregation at grain boundaries in two γ′-strengthened, fcc Fe-Ni-Cr alloys that display radiation-induced intergranular fracture. Scanning Auger electron spectroscopy (AES) of grain boundary fracture surfaces and analytical electron microscopy (AEM) of intact grain boundaries using energy-dispersive x-ray spectroscopy show good agreement on the nature and extent of segregation. The elements Ni, Si, Ti, and Mo are found to accumulate in G, Laves and γ′ phases on the grain boundaries. Segregation of P is detected by AES. The complementary features of the two analytical techniques are discussed briefly.

32162 **(CONF-860421—34) Effect of helium on swelling and microstructural evolution in ion-irradiated V-15Cr-5Ti alloy.** Loomis, B.A.; Kestel, B.J.; Gerber, S.B.; Ayrault, G. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010510.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

An investigation was made on the effects of implanted helium on the swelling and microstructural evolution that results from energetic single- and dual-ion irradiation of the V-15Cr-5Ti alloy. Single-ion irradiations were utilized for a simulated production of the irradiation damage that might be expected from neutron irradiation of the alloy in a reactor with a fast neutron energy spectrum ($E > 0.1$ MeV). Dual-ion irradiations were utilized for a simulated production of the simultaneous creation of helium atoms and irradiation damage in the alloy in the MFR environment. Experimental results are also presented on the radiation-induced segregation of the constituent atoms in the single- and dual-ion irradiated alloy.

32163 **(CONF-860421—35) Comparison of swelling for structural materials on neutron and ion irradiation.** Loomis, B.A. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31109-ENG-38. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010497.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

The swelling of V-base alloys, Type 316 stainless steel, Fe-25Ni-15Cr alloys, ferritic steels, Cu, Ni, Nb-1% Zr, and Mo on neutron irradiation is compared with the swelling for these materials on ion irradiation. The results of this comparison show that utilization of the ion-irradiation technique provides for a discriminative assessment of the potential for swelling of candidate materials for fusion reactors.

32164 **(CONF-860421—36) Effect of heat treatment and impurity concentration on some mechanical properties V-15Cr-5Ti alloy.** Loomis, B.A.; Kestel, B.J.; Diercks, D.R. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010498.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

The effects of heat treatment and O, N, C, Si, and S impurity level on the yield strength, ductility, and fracture mode for specimens from four different heats of the V-15Cr-5Ti alloy are presented. The heat treatments for the alloy consisted of annealing as-rolled material for one hour at either 950, 1050, 1125, or 1200°C. The total oxygen, nitrogen, and carbon impurity concentration ranged from 400 to 1200 wppm. The Si concentration ranged from 300 to 1050 wppm, and the S concentration ranged from 440 to 1100 wppm. The yield strength and ductility for the alloy, regardless of impurity concentration, exhibited minimum and maximum values, respectively, for the 1125°C anneal. The primary mode of failure for the tensile specimens was transgranular fracture.

32165 **(CONF-860421—37) Microstructural development of PCAs irradiated in HFIR at 300 to 400°C.** Tanaka, M.P.; Maziasz, P.J.; Hishinuma, A.; Hamada, S. (Oak Ridge National Lab., TN (USA); Japan Atomic Research Inst., Tokai, Ibaraki. Dept. of Fuels and Materials Research). 1986. Contract AC05-84OR21400. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010394.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Microstructural developments were determined on solution-annealed (SA) and cold-worked (CW) JPCA and US PCAs irradiated in the High Flux Isotope Reactor (HFIR) at 300 and 400°C. Irradiation produced damage levels of about 10 and 34 dpa and helium concentrations of around 580 and 2500 at. ppM, respectively. High concentrations of fine bubbles and MC precipitates, as well as Frank faulted loops, were observed in both SA and CW PCAs. Mutual stability of the MC particles and associated fine bubbles contributed to the extension of the transient regime of swelling to higher fluence. The irradiation responses of JPCA and US-PCA were similar in the HFIR, despite minor compositional differences (P,B) between the two materials. Useful fusion applications of SA-PCA as well as CW-PCA in the 300°C temperature range are suggested from these data.

32166 **(CONF-860421—39) Collapse of defect cascades to dislocation loops.** Kirk, M.A.; Robertson, I.M.; Jenkins, M.L.; English, C.A.; Black, T.J.; Vetrano, J.S. (Argonne National Lab., Evanston, IL (USA); Illinois Univ., Urbana (USA); Oxford Univ. (UK)). Apr 1986. Contract W-31-109-ENG-38. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010519.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

We review a number of experiments that we have recently performed to investigate the collapse of defect cascades to dislocation loops. This important ion and neutron irradiation phenomenon has been studied with in situ ion bombardment in the Argonne National Laboratory High Voltage Electron Microscope-Ion Accelerator Facility at temperatures of 30 and 300°K in Cu_3Au, Cu, and Fe, and 30, 300 and 600°K in Ni. These experiments have demonstrated that individual defect cascades collapse to dislocation loops athermally at 30°K in some materials (Ni, Cu and Cu_3Au), while in another material (Fe) only overlapped cascades produced dislocation loops. A slight sensitivity to the irradiation temperature is demonstrated in Cu_3Au and Fe, and a strong dependence on the irradia-

tion temperature is seen in Ni. This phenomenon of cascade collapse to dislocation loops in metals at 30°K provides an understanding for previous neutron irradiation data. The more detailed dependencies of the collapse probability on material, temperature, bombarding ion dose, ion energy and ion mass contribute much information to a thermal spike model of the collision cascade which we will describe.

32167 **(CONF-860421—40) Influence of temperature and lithium purity on corrosion of ferrous alloys in a flowing lithium environment.** Chopra, O.K.; Smith, D.L. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 30p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010507.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Corrosion data have been obtained on ferritic HT-9 and Fe-9Cr-1Mo steel and austenitic Type 316 stainless steel in a flowing lithium environment at temperatures between 372 and 538°C. The corrosion behavior is evaluated by measurements of weight loss as a function of time and temperature. A metallographic characterization of materials exposed to a flowing lithium environment is presented.

32168 **(CONF-860421—41) Compatibility of ferrous alloys in a forced circulation Pb-17Li system.** Chopra, O.K.; Smith, D.L. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010506.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Corrosion data have been obtained on ferritic HT-9 and Fe-9Cr-1Mo steel and austenitic Type 316 stainless steel in a flowing Pb-17 at. % Li environment at temperatures between 371 and 482°C. The corrosion behavior is evaluated by measurements of weight loss and depth of internal corrosion as a function of time and temperature. Metallographic examination of the materials exposed to the flowing Pb-17Li environment is presented.

32169 **(CONF-860610—18) Tensile behavior of helium-implanted and neutron-irradiated V-15Cr-5Ti.** Grossbeck, M.L.; Horak, J.A. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007301.

From American Nuclear Society annual meeting; Reno, NV, USA (15 Jun 1986).

Vanadium alloys are being considered for use for first-wall and blanket structures in fusion reactors due to their high melting points and low neutron activation. The alloy to be reported here, V-15Cr-5Ti, was prepared by Westinghouse Advanced Reactors Division (Heat HSV-307). Since the fusion environment produces helium in all common structural alloys including vanadium, the effect of helium in irradiated alloys was investigated. In a fusion reactor spectrum, about 5 at. ppM He/dpa is expected. Ideally, the helium should be produced concurrently with displacement damage. However, since this is difficult or impossible in vanadium without a source of high energy neutrons, cyclotron implantation of helium followed by fission reactor irradiation was chosen. By this method it was hoped to qualitatively scope the effect of helium alone and the synergistic effect of helium in conjunction with neutron irradiation.

32170 **(CONF-8604116—2) Overview of transport mechanisms in β-lithium/aluminum.** Susman, S.; Brun, T.O.; Volin, K.J. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010522.

From International workshop on high temperature molten salt batteries; Argonne, IL, USA (16 Apr 1986).

A systematic study over a period of years has resulted in identifying (a) constitutional defects in β-LiAl at room temperature and (b) defects created at elevated temperatures. The relationship between these defects and charge and mass transport is discussed. The results bear upon the use of LiAl as the negative electrode both in room-temperature and solid state batteries and in high-temperature, molten-salt electrochemical cells. The key to unravelling the Li-conduction mechanism has been the recognition that there is a critical composition within the β-phase domain corresponding to 50.7 at. % lithium. Free Li vacancies, bound Li vacancies, and reciprocal antisite defects contribute to the transport processes depending on temperature and composition. An understanding of these microscopic mechanisms has been used to remedy the loss of capacity with cycling of high temperature electrochemical cells.

32171 (DOE/ER/40048—102-L4, pp 64-65) **Light ion irradiation creep.** Bradley, E.R.; Henager, C.H., Jr.; Simonen, E.P.; Stang, R.G. (Pacific Northwest Lab., Richland, WA). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The US Department of Energy, Office of Basic Energy Sciences, supports a Radiation Effects on Metals and Ceramics program at Battelle, Pacific Northwest Laboratory (PNL). A light ion irradiation creep experiment, as part of the PNL research program, is being conducted at the Nuclear Physics Laboratory. Irradiation creep is defined as the time-dependent deformation of a material induced by stress during energetic particle irradiation in excess of that observe in the absence of irradiation. Pure nickel specimens were bombarded with deuterons, using the Van de Graaff accelerator, to further the understanding of low-dose irradiation creep mechanisms. An irradiation creep model developed to explain irradiation creep of nickel has been able to rationalize all the irradiation creep data obtained during this experiment.

32172 **(DOE/ER/45094—3) Improvement in high magnetic field behavior of vanadium-gallium superconductors by enhancement of spin-orbit scattering. Progress report.** Tedrow, P.M.; Meservey, R.H. (Massachusetts Inst. of Tech., Cambridge (USA). Francis Bitter National Magnet Lab.). 14 Feb 1986. Contract FG02-84ER45094. 5p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86007857.

Goal is to increase the critical magnetic field in V_3Ga, by adding high Z impurities. V_3Ga films 10 nm thick have been studied. A 6-nm Al over layer was found to optimize T/sub c/. 0.5 nm Ta overlayer also increased T/sub c/. There is zero field effect. Tunneling measurements on 10 nm V_3Ga show important Fermi-liquid effects. (DLC)

32173 **(DOE/ER/45096—T2) Stability of amorphous metal films on semiconductor substrates. Progress report, January-December 1985.** Wiley, J.D.; Perepezko, J.H. (Wisconsin Univ., Madison (USA)). 15 Jan 1986. Contract FG02-84ER45096. 9p. NTIS, PC A02. File Number DE86010362.

Goals involved overlayer and substrate studies, with emphasis on the amorphous Ni-Nb and W-Si alloy systems. Progress has been made in the identification of reactive overlayer/amorphous alloy/substrate combinations and in understanding the reactive paths and mechanisms of specific systems. (DLC)

32174 **(DP-MS—85-130) Strain analysis for extrusion of powder metals.** Berghaus, D.G.; Primas, R.J.; Peacock, H.B. (Georgia Inst. of Tech., Atlanta (USA). School of Engineering Science and Mechanics; Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.). 1986. Contract AC09-76SR00001. 27p. (CONF-860682—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86007167.

From SEM spring conference on experimental mechanics; New Orleans, LA, USA (8 Jun 1986).

This paper describes an experimental-numerical method for determining the strain distribution during axisymmetric extrusion of powder metals (P/M). The visioplastic method is modified to include variable density. The method is applied to extrusion of a powder aluminum billet. It was found that the smoothed-spline approximation functions did not permit sufficiently good fits adjacent to the boundaries of the approximation intervals due to the prescribed "zero" values of the second derivatives at the spline boundaries. The smoothed-spline was modified to permit specified boundary second derivatives.

32175 **(EIR—533) Calculated radiation damage effects of high energy proton beams.** Green, S.L. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Nov 1984. 8p. Also published in "J. Nucl. Mater.", September 1984, Vol. 126(1) p. 30-37.

The radiation damage effects produced by 600-800 MeV protons include displacement cascades, helium and hydrogen gases and heavy impurities. These effects were calculated using the nucleon meson transport code for the nuclear reactions produced by the protons and the theory of Lindhard et al. for the resultant damage energy. Aluminium was chosen as the primary metal in this study as it is being used in proton irradiation experiments. Results are also reported for copper, type 316 stainless steel, titanium, vanadium, and molybdenum.

32176 **(EIR—568) J-integral flaw resistance curves of Incoloy 800H at room temperature. Tests within the frame of round robin tests.** Krompholz, K.; Ullrich, G. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Aug 1985. 43p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86702044.

J-integral experiments at room temperature were performed on three point bend type specimens of the iron-nickel base alloy Incoloy 800H with a/w-ratios of 0.3 and 0.5. These experiments are performed within the frame of a round robin test in cooperation with German- and US-partners. The tests were performed in stroke control as well as in load control. Three different evaluation procedures were applied: -The signal of the dc potential drop technique - The partial unloading procedure and -The multiple specimen technique. Evaluating the dc potential drop technique and the multiple specimen method delivered reasonable results while the partial unloading procedure failed. The different methods are discussed and fractographic results support these results under discussion.

32177 **(EPRI-CS—4515) Titanium L-1 steam turbine blade retrofit. Final report.** Warner, R.E.; Thomas, J.P.; Rust, T.M. (Westinghouse Electric Corp., Orlando, FL (USA). Power Generation Operating Div.). May 1986. 99p. Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303. File Number TI86920271.

The purpose of this project is to investigate the feasibility of titanium as a steam turbine blading alloy, particularly for application to the transition zone where corrosion-assisted blade failures have been a problem. This investigation includes both mechanical feasibility as well as the relative corrosion resistance. As part of the program a row of titanium blades, as well as a nearly identical row of steel blades, have been designed, manufactured and installed in an operating turbine, which has previously experienced corrosion-assisted blade distress. The steel blades provide a basis by which to judge the effect of the material change on blade stress and reliability. The relative responses of both steel and titanium blades under actual service conditions have been measured in a field telemetry test. The results of the field telemetry test do not indicate a higher stress response level for the titanium blade or any abnormal response due to the lower material damping. The titanium blade meets all requirements and, consequently, titanium has been qualified as a steam turbine blading alloy. The relative corrosion resistance of titanium in this environment will be determined by the long term blade reliability under operating conditions. 7 refs., 31 figs., 10 tabs.

32178 **(EPRI-CS—4546) Mechanisms of failure of coatings used in flue gas desulfurization systems.** Leidheiser, H. Jr.; White, M.L.; Granata, R.D.; Vedage, H.L. (Lehigh Univ., Bethlehem, PA (USA). Sinclair Lab.). May 1986. 107p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920267.

Coating resins were evaluated for their ability to protect steel against corrosion in acid environments. Four types of resins (vinylester, fluoropolymers, epoxies, and a polyester) were applied to sandblasted steel surfaces and exposed to either 0.1M H_2SO_4 or a solution containing $MgCl_2$ and NaF that was about 1M in H_2SO_4. Measurements were made of cathodic delamination rates, corrosion potential, AC coating conductance, tensile adhesion, weight gain and the visual appearance of the coating and substrate. A failure mechanism was developed: acid diffuses through the coating, reacts with the underlying steel to oxidize it, with attendant reduction of the hydrogen ion to hydrogen gas. Debonding of the coating results. If the hydrogen gas is formed at a greater rate than it diffuses out through the coating, a blister is formed. If swelling of the polymer coating occurs in the environment, the blistering rate is increased by the concurrent effects of swelling and hydrogen generation. Different physical and chemical pretreatments of the steel had some effect on the initial values of some of the coating parameters, but after several hundred hours of acid exposure, these differences disappeared. Coating resins were evaluated for their ability to provide corrosion protection. A vinyl ester and a fluoropolymer were the most effective. A polyester and an epoxy hardened with a polyamideamine were the least effective.

32179 **(EPRI-CS—4562) Effects of sulfide, sand, temperature, and cathodic protection on corrosion of condensers.** Gehring, G.A. Jr. (Ocean City Research Corp., NJ (USA)). May 1986. 159p. Research Reports Center, Box 50490, Palo Alto, CA 94303. File Number TI86920272.

This report summarizes the results of a two-year laboratory study undertaken to develop data under simulated flow conditions that will provide better insight on different condenser corrosion problems and practical alternatives for their solution. The study acquired comparative data on various forms of corrosion as related to sulfide pollution of cooling water, cooling water temperature, and suspended sand in the cooling water. The effect of cathodic protection applied at different levels was also investigated. The program included four typical condenser tube alloys (titanium, 90-10 Cu-Ni, 70-30 Cu-Ni, aluminum brass) and two tubesheet alloys (Muntz metal, aluminum bronze-alloy D). The results demonstrated that: (1) sulfide pollution of condenser cooling water can greatly aggravate various forms of condenser corrosion and can impede cathodic protection (2) suspended sand in condenser cooling water may increase tube corrosion rates (3) cooling water temperature can directly affect the extent and degree to which various forms of corrosion will tend to occur and (4) cathodic protection can be used to mitigate selected forms of condenser corrosion. 18 refs., 50 figs., 29 tabs.

32180 **(EPRI-EM—4508) Induction melting of metals: state-of-the-art assessment. Final report.** Raghupathi, P.S. (Battelle Columbus Labs., OH (USA)). Apr 1986. 55p. Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303. File Number TI86920275.

Induction melting contributes significantly to productivity in the melting and refining of iron, steel, aluminum, zinc, copper, and other nonferrous alloys. Projected equipment sales, coupled with the efficiency of induction melting furnaces - primarily coreless and channel units - suggest that electricity consumption in metal-processing industries will increase gradually through 1990.

32181 **(IAE—4020/11) Nucleation model for vacancy complexes in damage cascade area.** Kapinos, V.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 25p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702015.

A nucleation model for large vacancy complexes in damage cascade area (DCA) has been suggested. Using the method of molecular dynamics (MMD), simulation of melting and crystallization of copper crystallite, containing vacancies is realized. It is shown that the "tightening" of the vacancies to the center of crystallite takes place if during its cooling in the volume the temperature profile, similar to the temperature profile in thermal peak, is maintained. Quantitative evaluation of the above mentioned effect is made and the way of its account in the model of vacancy complex nucleation is suggested. Simulation of spatial redistribution of the defects in DCA of 30 keV cascade in copper is carried out and distribution of vacancy complexes as to dimensions is obtained.

32182 **(INIS-BR—460) Determination of the annealing for AISI 430 steel in a continous furnace.** Pinto, A.H.; Diab Junior, A. (Fundacao Percival Farquhar, Governador Valadares (Brazil). Inst. de Tecnologia). 1984. 18p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702010.

A mathematical model is discussed, which represents the heating of a steel piece inside a continuous annealing furnace. The experimental technique used to obtain good annealing conditions for a required quality is described.

32183 (INIS-BR—462, pp 1-5) **Effect of the hypo and hyperstoichiometry of niobium about the solidification of steel with medium carbon content.** Kestenbach, H.-J.; Rodrigues, J.A.; Makray, E.T. (Sao Carlos Univ., Brazil. Dept. de Engenharia de Materiais; Universidade Estadual de Campinas, Brazil. Dept. de Engenharia Quimica). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The solidification sequency and the microstructure from carbon steel with 0.4%C and several contents of Nb were investigated. Additions between 1 and 5% in Nb weight to obtain compositions with hypo and hyperstoichiometric in relation to the niobium carbide formation were used. The metallographic observations were interpreted based in several solidifications reactions that could be occur in the iron rich region of the ternary diagram Fe-Nb-C.

32184 (INIS-BR—462, pp 40-43) **Niobium segregation in the austenitic grain boundary.** Mei, P.R.; Farah, E.A. (Universidade Estadual de Campinas, Brazil. Faculdade de Engenharia; Universidade Estadual de Campinas, Brazil. Inst. de Fisica). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The segregation of niobium and carbon in the boundary of the old austenitic grain (martensitic sample) of a steel 0,4%C/0,03%Nb, homogenized in 1350°C for one hour, with the help of the ionic microprobe, using oxygen as primary beam, is studied. The niobium segregation in Fe /0,58Nb homogenized samples at 1300°C by 8 hours and cooled in water, using the electronic microprobe is also studied.

32185 (INIS-BR—462, pp 44-48) **Investigation of the ternary system Nb-Ti-Al.** Kaltenbach, K.; Gama, S. (Max-Planck-Institut fuer Metallforschung, Stuttgart, Germany, F.R.; Fundacao de Tecnologia Industrial, Lorena, Brazil. Projeto Niobio). 1984. NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The binary systems Nb-Ti, Nb-Al and Al-Ti as well the ternary system Nb-Ti-Al were studied by the aid of arc-beam melted alloys. The as-cast alloys and samples heat treated at 1200°C were examined and the liquidus surface projection, an isothermal section at 1200°C and the reaction scheme of the system Nb-Ti-Al were constructed. The phase relations of the binary systems Nb-Ti and Nb-Al were confirmed. In the system Al-Ti still some examinations are necessary to resolve the existing uncertainties. The melting process of Nb-Ti alloys in the electron-beam furnace has been studied.

32186 (INIS-BR—462, pp 68-72) **Structural changes of carbides in a high-speed steel - M2 - after hardness and drawing back.** Santos, D.B.; Luz Ferreira, O. da; Ribeiro, O.L.R.; Franca Junior, W.S. (Minas Gerais Univ., Belo Horizonte, Brazil. Escola de Engenharia; Companhia Siderurgica Paulista, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The microstructure of a high-speed steel was studied through the scanning electron microscope. The carbide chemical composition was determined by the X-ray energy spectroscopy. The analyses were done in situ and in precipitate extracted from carbon replica. The phases were shown through the X-ray diffraction in the wastes from electrolytic use. In the annealed structure, some carbides such as M_6C, MC and $M_{23}C_6$, and in the annealed and drawing back structure, carbides such as M_6C and MC, were seen. The volumetric fraction of each type was calculated by quantitative metallography. The utilization of the replica technique allows the analysis of carbides smaller than 1 μm without the matrix interference.

32187 (INIS-BR—462, pp 275-277) **Diffraction study in a selected area of the deformation field around cracks of Nb-H.** Bulhoes, I.A.M.; Akune, K. (Sao Paulo Univ., Sao Carlos, Brazil. Inst. de Fisica e Quimica; Sao Carlos Univ., Brazil. Dept. de Engenharia de Materiais). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

Using the selected area diffraction technique in the scanning electron microscope, it is possible to measure the deformation field around a Nb-H cracks. The deformation can be described as epsilon (r) approx. C exp (-Kr). The constant values are in the range of $0.05 <= C <= 0.15$ and $0.03 <= K <= 0.1$ (1/μm). This field has short-range and shows fast deformation relaxation with the corrosion.

32188 (INIS-BR—462, pp 6-9) **Hardness in high temperature of steels ABNT H11 and ABNT H11 modified with niobium.** Goncalves, R.A.; Boratto, F.J.M. (Universidade Federal de Uberlandia, Brazil. Dept. de Ciencias Fisicas; Centro Tecnologico, Belo Horizonte, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

A method to measure the hardness of metallic materials was developed. The heating was done by the Joule effect heat dissipation in the sample, that is like an electrical resistor. A diamond penetrator with a revolution paraboloid format was used that assured a linear relation between the load applied and the penetration depth. Hardness tests were made in the range of 25 - 600°C in the steels ABNT H11 and ABNT H11 modified with niobium, with the simultaneous register of the applied force, penetration depth and temperature.

32189 (INIS-BR—462, pp 189-193) **Creep in the stainless steel 316 irradiated with fast neutrons and alpha particles of 28 MeV.** Segura, E.; Lucki, G.; Aguiar, D.; Monteiro, W.A. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

A device to make creep tests in thin samples is described, and the experimental results from stainless steel 316 with 50% cold reduction and 100μm of thickness are presented. The measurements were done in vaccuum $<10^{-5}$ Torr and temperatures of 657°C and 700°C, with variations about +-1°C, with applied stress of 200 MPa. The sample deformation was measured with a sensor like LVDT with sensitivity of 5.10^-5. The irradiations were made using the IEA-R1 reactor (neutrons) and the cyclotron CV-28 (alpha particles) at IPEN-CNEN/SP. The neutron integrated flux was 1.7 x 10^{18} n.cm^{-2} and the helium concentrations were 5 and 26 appm. Metallographic analysis and TEM analysis were done in the initial and irradiated materials.

32190 (INIS-BR—462, pp 35-39) **Use of niobium as a substitute to molybdenum in steels with high oxidation resistance.** Benazzi Junior, I.; Almeida Rollo, J.M.D. de. (Sao Paulo Univ., Sao Carlos, Brazil. Escola de Engenharia). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

Some alloys were melted using as a base the composition of the austenitic stainless steel (AISI-316L) in which total and partial substitutions of molybdenum to vanadium were done. Oxidation tests in 700°C and 800°C, mechanical tests and metallographic studies were done.

32191 (INIS-BR—462, pp 91-95) **Oxidation behavior of Zr and its alloys.** Costa, I.; Ramanathan, L.V. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The environment effect, material composition, thermal treatment and superficial treatment on the oxidation behavior of Zr, Zircaloy-4 and Zr - 2,5% Nb, in the temperature range of 400 - 900°C, by thermogravimetry were studied.

32192 (INIS-BR—462, pp 281-285) **Superficial oxidation in mono and polycrystalline niobium films for Josephson joints.** Celaschi, S.; Geballi, T.H. (Vicosa Univ., Brazil. Dept. de Fisica; Stanford Univ., CA, USA. Dept. of Applied Physics). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

Niobium thin films (Nb) with multigranular and monocrystalline structure with 3000 A of thickness were put in different temperatures on sapphire monocrystalline substrate by high vacuum evaporation technique (10^{-9} Torr). The evaporation process and some of the structural properties of the films are described. The oxidation process is studied through the characteristics of the current curves x voltage measured in low temperature (4.2 K).

32193 (INIS-BR—462, pp 49-52) **Effect of electronic radiation in Nb monocrystals.** Otero, M.P.; Lucki, G. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The effect of the electronic irradiation in the Nb monocrystalline samples is studied. The irradiation source were electrons from the high voltage electronic microscope from the Argonne National Laboratory operating at 900 KeV. With the irradiation and deformation 'in-situ' experiments, dislocations in the samples were observed and the effect of the electrons in those dislocations during 59m of irradiation was studied. The following applied deformation showed the differences in the displacements behavior of the non-irradiated and irradiated region. The growth rate of the displacements rings were determined.

32194 **(Juel—1975) Spectrometric and metallographic examinations of corrosion and precipitation products of high temperature alloys.** Mayer, W.; Mazurkiewicz, M.; Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorwerkstoffe; Technische Hochschule Aachen (Germany, F.R.)). Feb 1985. 129p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752020.

By means of an electrochemical technique, the corrosion layers formed on samples of Inconel 617 and Incoloy 800 H in a synthetic process gas during different ageing periods in the temperature range between 800-950°C were separated. For a quantitative analysis of the corrosion products, an inductively coupled plasma (ICP) was used as excitation source for the spectroscopic analysis. This method of analysis is characterized by a high detection efficiency and a good reproducibility. The horizontal and vertical distribution of the line intensities and the matrix effects occuring during the analysis of the electrolyte solution were investigated in inductively coupled N_2/Ar- and Ar/Ar-plasma systems. The ICP quantitative analysis date were compared with those of the metallographic post-examination of the corrosion layers formed and with the results of X-ray diffraction analysis and microprobe measurements. (orig./IHOE).

32195 **(KAPL—4192) Mechanical behavior of superalloys.** Floreen, S. (Knolls Atomic Power Lab., Schenectady, NY (USA)). Apr 1986. Contract AC12-76SN00052. 37p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010353.

Recent developments affecting the mechanical behavior of superalloys over three ranges of operating temperatures are reviewed. At lower temperatures, activity has been focused on stress corrosion cracking susceptibility in light water reactor and sour gas well environments. The susceptibility to intergranular crack growth is critically dependent upon the grain boundary chemistry, and a method of minimizing the sensitivity of the boundaries to attack has been pursued. At intermediate temperatures, considerable effort has been directed toward increasing the tensile and fatigue strengths. The higher strength materials, however, show increased fracture sensitivity. In particular, embrittlement due to diffusion into the grain boundaries of aggressive species, such as oxygen or sulfur from the environments, becomes a problem. Minor element alloying additions of boron, zirconium, magnesium, etc., are helpful in retarding the degradation caused by the environment. At higher temperatures, the major thrust is toward improving the creep strength. The weak link in the materials, which is the transverse grain boundaries, has been eliminated by the use of specialized processing steps to produce either directionally solidified materials with minimum transverse grain boundaries, or single crystal materials. Single crystal materials permit alloying and heat treating modifications that further enhance the creep strength. The materials are very anisotropic in properties, but are successfully used in turbine blades and could be useful in other special applications.

32196 **(LA—10708-T) Coupled thermomechanical-diffusion of mobile constituents in a deformable solid.** Girrens, S.P. (Los Alamos National Lab., NM (USA)). Apr 1986. Contract W-7405-ENG-36. 121p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86008225.

Solid mixtures containing initially uniform dilute concentrations of impurity elements may, upon application of mechanical and thermal loading, develop regions of high impurity concentration causing local degradation in material properties. In order to address these degradation processes, a nonlinear coupled thermomechanical-diffusion theory, based on the principles of modern continuum mechanics, is developed to model the thermal and mechanically assisted mass transport of mobile constituents through a solid deformable parent material. Numerical results obtained are compared with closed-form analytical solutions of simplified one-dimensional problems. The coupled theory and the resulting finite element code have been used to simulate experiments on stress assisted diffusion of hydrogen in β-phase titanium alloys. Comparisons are made between the published data from these experiments and the predictions of the code demonstrating the validity of the theory and code. Similar simulations and comparisons are presented for published data on nitrogen diffusion in ion-implanted AISI type-304 stainless steel.

32197 **(LA-UR—86-1156) Field ion microscopy study of depleted zones in tungsten after proton irradiation.** Farnum, D.J.; Sommer, W.F.; Inal, O.T.; Yu, J. (New Mexico Inst. of Mining and Technology, Socorro (USA); Los Alamos National Lab., NM (USA); Academia Sinica, Beijing (China). Inst. of Atomic Energy). 1986. Contract W-7405-ENG-36. 18p. (CONF-860421—29). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010165.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Depleted zones in tungsten, that resulted from medium-energy proton irradiations, were studied using the Field Ion Microscope (FIM). The shapes and sizes of depleted zones is an important aspect of basic radiation damage. These data can be compared to models that have been suggested as well as aid development of new models. These depleted volumes are of interest not only for an understanding of basic radiation effects, but also because they affect material properties and can act as nucleation sites for voids or gas bubbles. Depleted zones were produced in annealed tungsten wires

by irradiation with 600 to 800 MeV protons at the Los Alamos Meson Physics Facility. The defects observed in the irradiated samples included vacancies, depleted zones, grain boundaries, and dislocations. Single vacancies were the most commonly observed defect. Of the samples "imaged," over 50 depleted zones were found within the area of high resolution in the area between the prominent [112] poles in a [110] oriented sample. The number of layers photographed in each sample was dependent upon the initial shape of the tip and ranged from 60 to 200 [110] sequential layers.

32198 **(LBL—21156) Theory of strengthening by ordered precipitates.** Glazer, J.; Morris, J.W. Jr. (Lawrence Berkeley Lab., CA (USA)). Feb 1986. Contract AC03-76SF00098. 18p. (CONF-8606107—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009355.

From International conference on aluminum alloys; Charlottesville, WV, USA (15 Jun 1986).

A model for the critical resolved shear stress neat peak strength of alloys hardened by ordered precipitates is developed. The model is applied to the specific case of δ' precipitates in binary aluminum-lithium alloys and found to be in good quantitative agreement with measured aging behavior. The effects of precipitate size, size distribution and shape on the critical resolved shear stress are explored via the model and predictions for more optimized microstructures presented.

32199 **(SAND—86-0470) Tensile behavior of ferritic ductile cast iron.** Salzbrenner, R.J. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 35p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010630.

Samples from eight heats were tested in the as cast condition, and in a heat treated state that produced a fully ferritic matrix. Tensile ductility was increased, and the ductile-to-brittle transition (as measured by Charpy impact testing) was shifted to lower temperatures as a result of the elimination of carbide by heat treatment. A multiple linear regression method was used to determine mathematical models showing the relationship between tensile properties and composition and microstructure. Strength (both yield and ultimate tensile) is dependent primarily on composition. Tensile ductility (as measured by elongation and reduction in area) is governed by a combination of composition and microstructure. Strength and ductility for ferritic ductile cast irons are thus, to some degree, independent, and therefore increases in ductility do not necessarily have to come at the expense of strength.

32200 **(UCRL—15799) Correlation of acoustic emission to microstructural sources. Final technical report.** Mohr, J.; Mukherjee, A.K. (California Univ., Davis (USA). Div. of Materials Science and Engineering). 26 Feb 1986. Contract W-7405-ENG-48. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010558.

Tensile tests were conducted on Fe-21Ni-.6C alloy to determine the relation between true strain and acoustic emission, magnetic susceptibility, and true stress. Results, presented as graphs, show cyclic behavior characteristic of serrated yielding. The magnetic and acoustic emission monitors were designed to be used during the deformation and hence they depicted the changes that occurred during the deformation.

32201 **Stability of metallic CsCl-structured alloys under ion irradiation.** Nastasi, M.; Lilienfeld, D.; Johnson, H.H.; Mayer, J.W. (Department of Materials Science and Engineering, Cornell University, Ithaca, New York 14853). *Journal of Applied Physics;* **59**: No. 12, 4011-4016(15 Jun 1986). Contract FG03-84ER45156.

The ion irradiation stability of the CsCl phases CoAl, IrAl, SiRu, and AuZn has been investigated. Thin-film (~ 500-A-thick) transmission electron microscopy samples were irradiated with Xe to a maximum dose of 4×10^{15} ions/cm^2 at room temperature. Irradiation-induced transformations in the compound samples were examined by transmission electron diffraction. The alloys CoAl, IrAl, and AuZn remained crystalline while SiRu became amorphous. Analysis of our findings and other previously reported experimental results indicate that CsCl compound stability under ion irradiation is strongly correlated with atomic mobilities.

32202 **Effect of dose rate on ion beam mixing in Nb-Si.** Banwell, T.; Nicolet, M.; Averback, R.S.; Thompson, L.J. (California Institute of Technology, Pasadena, California 91125). *Applied Physics Letters;* **48**: No. 22, 1519-1521(2 Jun 1986). Contract W-31-109-ENG-38.

The influence of dose rate, i.e., ion flux, on ion beam mixing in Nb-Si bilayer samples was measured at room temperature and 325 °C. At the higher temperature, an increase in dose rate of a factor of 20 caused a decrease in the thickness of the mixed layer by a factor of 1.6 for equal total doses. At room temperature, the same change in flux had no effect on mixing. These results are consistent with radiation-enhanced diffusion theory in the recombination-limited regime.

32203 **Stability of multilayers for synchrotron optics.** Ziegler, E.; Lepetre, Y.; Schuller, I.K.; Spiller, E. (Materials Science and Technology Division, Argonne National Laboratory, Argonne, Illinois 60439). *Applied Physics Letters;* **48**: No. 20, 1354-1356(19 May 1986). Contract W-31-109-ENG-38.

The temperature stability of metal (W, WRe, Co, Cr)-carbon multilayers has been studied using x-ray diffraction (θ—2θ and Debye—Scherrer) and electron microscopy. The results show that in all cases a crystallization occurs in the temperature range 650—750 °C. As a consequence of this crystallization, the layered structure is destroyed, the surface of the film becomes rough, and the x-ray reflectivity is considerably reduced. These results imply that efficient cooling or new multilayer structures will have to be developed for use at high temperatures or under high x-ray incident flux.

32204 **Analytical technique for deriving the distribution of critical currents in a superconducting wire.** Warnes, W.H.; Larbalestier, D.C. (Applied Superconductivity Center, University of Wisconsin—Madison, Madison, Wisconsin 53706). *Applied Physics Letters;* **48**: No. 20, 1403-1405(19 May 1986).

The derivation of the critical current or critical current density distribution from an analysis of the voltage-current characteristic of a composite superconductor is discussed. Critical current distributions have been obtained for three Nb-Ti composites in quite different metallurgical states. The distribution is shown to be markedly broadened when sausaged filaments produce an extrinsic limit on the composite critical current.

32205 **Fermi surface of field-induced ferromagnetic CeSb.** Norman, M.R.; Koelling, D.D. (Materials Science and Technology Division, Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review [Section] B: Condensed Matter;* **33**: No. 10, 6730-6738(15 May 1986).

The Fermi surface of ferromagnetic CeSb is analyzed with use of a model in which the f electrons in the system are treated as localized (unhybridized) $j = (5/2)$, $\mu = (5/2)$ states interacting only weakly with the conduction electrons through electrostatic and exchange interactions. The ordering of the f orbital moments along the [001] easy-magnetization axis breaks the cubic symmetry introducing noncubic contributions to the potential seen by the conduction electrons. Because spin-orbit coupling in the conduction bands proves quite significant, the requisite model includes both the spin-orbit coupling and the polarization effects. The application of the model compares quite favorably with the measured de Haas—van Alphen frequencies except that the calculated polarization splittings, while quite small, are still overly large. It is found that the electron masses have little or no enhancement beyond the electron-phonon enhancement.

32206 **Phonon anomalies and linewidths in Nb at 10 K.** Wakabayashi, N. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831 and Department of Physics, Keio University, Yokohama 223 Japan). *Physical Review [Section] B: Condensed Matter;* **33**: No. 10, 6771-6774(15 May 1986). Contract AC05-84OR21400.

The phonon linewidths in Nb at 10 K have been measured in detail by neutron scattering techniques. The results are in good agreement with the theoretical values of the first-principles calculation by Butler et al. The contributions of electron-phonon interactions to the observed linewidths as well as to the anomalies in the

phonon-dispersion curves are discussed on the basis of a phenomenological charge-fluctuation model. In addition, strong temperature dependences of the longitudinal-mode frequencies were detected. They are interpreted as indications of a large temperature dependence of the coupling between the monopolar charge fluctuations and atomic displacements.

32207 **Electrical-transport properties in the semimetallic compound LiGa.** Kuriyama, K.; Volin, K.J.; Brun, T.O.; Susman, S. (Materials Science and Technology Division, Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 10, 7291-7293(15 May 1986). Contract W-31-109-ENG-38.

The temperature-dependent electrical resistivity above 15 K and the room-temperature Hall coefficient of Li-Ga are presented for five different Li concentrations. The temperature-dependent part of the resistivity is independent of the Li concentration. However, the residual resistivity increases very rapidly with increasing Li concentration. These results suggest that the defects in Li-Ga consist of two types, namely, vacancies on the Li sublattice and Li antisite atoms on the Ga sublattice. An anomaly near 230 K is observed for samples for the Li-deficient phase. This anomaly is associated with the ordering of vacancies on the Li sublattice. Li-Ga is a semimetallic compound with a "hole" as the majority carrier.

32208 **Intensity oscillations in the inverse photoemission cross section of an unoccupied surface state on Cu(001).** Hulbert, S.L.; Johnson, P.D.; Garrett, R.F. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 10, 7326-7328(15 May 1986).

It is shown that inverse photoemission cross sections of unoccupied surface states are subject to the same intensity oscillations as are observed in ordinary photoemission studies of occupied surface states. In particular, we compare observations of the unoccupied surface-state intensity as a function of k/sub perpendicular/ with a calculation of the bulk band structure obtained using a combined interpolation scheme. We are able to show that the surface state peaks in intensity at that value of k/sub perpendicular/ for which it lies closest to the bulk band from which it is derived.

32209 **Critical behavior in the Ising antiferromagnet $MnTe_2$.** Hastings, J.M.; Corliss, L.M.; Kunnmann, W.; Mukamel, D. (Department of Chemistry, Brookhaven National Laboratory, Upton, New York 11973). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 9, 6326-6330(1 May 1986). Contract AC02-76CH00016.

Symmetry considerations indicate that although $MnTe_2$ has cubic symmetry, the antiferromagnetic transition in this compound is Ising-like. Critical properties of $MnTe_2$ have been studied in the reduced temperature range 5 x 10^{-4} < or = ' t ' = ' (T-T/sub N/) / T/sub N/' < or = 1 x 10^{-1} by neutron scattering techniques. It is found that the critical exponent $\beta = 0.431 +- 0.009$ is anomalously large, while the value of $\nu = 0.635 +- 0.014$ is in reasonable agreement with the expected theoretical estimates. The exponents can be reconciled with the theoretical values by application of corrections to scaling. However, the size of some of the corrections and the increased uncertainties in the exponents produced by the introduction of additional fitting parameters, make it difficult to be sure the analysis is justified.

32210 **Measurement of acoustic phonons in UBe_{13}.** Robinson, R.A.; Axe, J.D.; Goldman, A.I.; Fisk, Z.; Smith, J.L.; Ott, H.R. (Physics Division, Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 9, 6488-6490(1 May 1986). Contract AC02-76CH00016.

The low-energy phonon dispersion of UBe_{13} has been measured by means of inelastic neutron scattering at room temperature and 10 K and elastic constants have been extracted. They are consistent with values obtained by scaling from pure beryllium, and the angular variation is almost isotropic. The lattice contribution to the low-temperature specific heat has been calculated from these data and is compared with the measured specific heats in the literature.

32211 **Ion mixing of Ni-Pt films on Si.** Sawada, T.; Pai, C.S.; Lau, S.S.; Poker, D.B.; Buchal, C. (Department of Electrical Engineering and Computer Sciences, University of California, San Diego, La Jolla, California 92093). *Journal of Materials Research;* **1**: No. 2, 322-326(Mar 1986). Contract FG03-84ER45156;AC05-84OR21400.

The reactions between bilayered Ni/Pt films and Si <100> substrates induced by thermal annealing and ion mixing were investigated. Thermal annealing of Si/Pt/Ni and Si/Ni/Pt samples led to layer reversal at low temperatures (~ 300° to 400°C) and the formation of a ternary phase at high temperatures (~ 700°C). These results are consistent with those reported in the literature. Ion mixing of both types of samples led to silicide formation without layer reversal. This effect is interpreted in terms of a change of moving species from metal (in thermal annealing) to Si (in ion mixing). The mixing efficiency between Pt and Ni is observed to be enhanced when Si is mixed together with these two metals.

32212 **Dependence of heavy-ion-induced adhesion on energy loss and time.** Stokstad, R.G.; Jacobs, P.M.; Tserruya, I.; Sapir, L.; Mamane, G. (Department of Nuclear Physics, Weizmann Institute of Science, Rehovot, Israel; Nuclear Science Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Journal of Materials Research;* **1**: No. 2, 231-233(Mar 1986). Contract AC03-76SF00098.

The ability of heavy-ion beams to enhance the adhesion of thin metallic films to substrates has been studied as a function of projectile species. Measurements of the adhesion enhancement of a thin gold film to substrates of tantalum and silicon (with native oxides) have been made for beams of ^{12}C, ^{16}O, ^{28}Si, ^{35}Cl, and ^{58}Ni at 2.85 MeV/nucleon. The threshold dose required to pass the Scotch tape peel test was found for the Au-Ta system to be Dth (cm^{-2}) = 10^{17} (dE/dx)/sup -3.0 plus-or-minus 0.2/ where dE/dx is the electronic stopping power (MeV mg^{-1} cm^2) of the ion in Au. For the Au—Si system, Dth = 6 x 10^{18} (dE/dx)/sup -4.1 plus-or-minus 0.3/. The steep dependence of Dth on dE/dx found here is in contrast with an earlier measurement for the Au—Ta system by Tombrello et al. The adhesion enhancement was observed to decrease with time after the bombardment in a manner suggesting that diffusion of atoms through the gold film is important. The possible importance of small concentrations of extraneous atoms at the interface is discussed.

32213 **Stability and formation of $NiAl_3$ under ion irradiation.** Nastasi, M.; Johnson, H.H.; Mayer, J.W.; Williams, J.M. (Department of Materials Science and Engineering, Cornell University, Ithaca, New York 14853). *Journal of Materials Research;* **1**: No. 2, 268-274(Mar 1986). Contract AC05-84OR21400.

Compound samples of $NiAl_3$ as well as $Ni_{23}Al_{77}$ multilayered samples have been irradiated by either Xe or Ne ions to doses of 2 x 10^{15} Xe ions/cm^2 and 1.3 x 10^6 Ne ions/cm^2 at temperatures of 100 K, 300 K, and 373 K. In the case of compound irradiation, $NiAl_3$ stability appears to be determined by regrowth kinetics and increased with lighter irradiating ion mass and higher irradiation temperature. The formation of $NiAl_3$ by ion mixing Ni/Al multilayers was not affected by irradiating ion mass and appears to be limited by nucleation.

32214 **Mechanisms and kinetics of ion implantation.** Lam, N.Q.; Leaf, G.K. (Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Materials Research;* **1**: No. 2, 251-267(Mar 1986). Contract W-31-109-ENG-38.

The evolution of the implant distribution during ion implantation at elevated temperatures has been theoretically studied using a comprehensive kinetic model. In the model foreign atoms, implanted into both interstitial and substitutional sites of the host lattice, could interact with implantation-induced point defects and with extended sinks such as the bombarded surface. The synergistic effects of preferential sputtering, radiation-enhanced diffusion, and radiation-induced segregation, as well as the influence of nonuniform defect production, were taken into account. The bombarded surface was allowed to move in either direction, -x or +x, depending on ion energy, i.e., on the competition between the rates of ion

deposition and sputtering. The moving surface was accounted for by means of a mathematical technique of immobilizing the boundary. The ion implantation process was cast into a system of five coupled partial differential equations, which could be solved numerically using a suitable technique. Sample calculations were performed for two systems: Si^+ and Al^+ implantations into Ni. It has been known from previous studies that in irradiated Ni, Si atoms segregate in the same direction as the defect fluxes, whereas Al solutes migrate in the opposite direction. Thus the effects of different segregation mechanisms, as well as the influence of target temperature, ion energy, and implantation rate on the evolution of implant concentrations in time and space, could be examined with the present model.

32215 **Creep behavior of a polycrystalline nickel aluminide: Ni-23.5 at.% Al-0.5 at.% Hf-0.2 at.% B.** Schneibel, J.H.; Petersen, G.F.; Liu, C.T. (Metals and Ceramics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Materials Research;* **1**: No. 1, 68-72(Jan 1986). Contract AC05-84OR21400.

The creep behavior of a polycrystalline nickel aluminide with the composition Ni-23.5 at.% Al-0.5 at.% Hf-0.2 at.% B has been measured as a function of stress, temperature, and grain size. At high stresses, of the order of 100 MPa, the strain rate is nonlinear in the stress, with a stress exponent greater than two. Below approximately 10 MPa, at 1033 K, the steady-state strain rate is almost proportional to the stress, indicating that diffusional creep is rate controlling. Calculations of expected Nabarro-Herring and Coble creep rates did not answer whether diffusive mass transport through the grains, or along the grain boundaries, is rate controlling. The grain-size dependence of the strain rate, however, indicates predominance of volume diffusion control, i.e., Nabarro-Herring creep, for our experimental conditions. aluminide

32216 **Nucleation and growth in surface-melted crystalline and amorphous $Fe_{40}Ni_{40}P_{14}B_6$ alloys.** Wallace, R.J.; Kaufmann, E.N. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Materials Research;* **1**: No. 1, 27-37(Jan 1986). Contract W-7405-ENG-48.

The well-known glass-forming alloy $Fe_{40}Ni_{40}P_{14}B_6$ was surface melted by an electron beam traversing its surface at various velocities in an identical manner for both the crystalline and the amorphous state of the alloy. Cross-sectional optical metallography and numerical heat-flow analysis were used to show that (1) crystallization of the amorphous state does not occur during treatment around or in the regrown layer at the highest processing speeds, a behavior consistent with an extrapolation of isothermal nucleation and growth measurements; (2) initial resolidification of the molten layer is always crystalline when the melt pool contacts underlying crystalline material where nucleation is immediate; and (3) solidification front velocities greater than 5 +- 0.5 cm/s exceed the maximum kinetic limit for growth of the crystalline phase and amorphous layers are formed, a result consistent with the eutectic nature of the alloy. Inconsistencies with the work of previous investigators of this system are discussed.

32217 **(Y/TR—86/7) Uranium manufacturing process employing the electrolytic reduction method.** Oda, Yoshio; Kazuhare, Manabu; Morimoto, Takeshi. (Oak Ridge Y-12 Plant, TN (USA); Asahi Glass Co. Ltd., Tokyo (Japan)). 1986. Contract AC05-84OS21400. Translation of Japanese Patent Disclosure No. 57-194290, November 29, 1982. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010644.

The present invention related to a uranium manufacturing process that employs the electrolytic reduction method, but particularly to a uranium manufacturing process that employs an electrolytic reduction method requiring low voltage. The process, in which uranium is obtained by means of the electrolytic method and with uranyl acid as the raw material, is prior art.

32218 **Alloys in energy development.** Frost, B.R.T. (Argonne National Lab., IL, USA). *Journal of the Less-Common Metals;* **114**: No. 1, 213-223(2 Dec 1985).

A survey is presented on the process of alloy development in support of efficient and complex energy systems. Especially, considered are uranium and plutonium oxides as nuclear fuels, austenitic stainless steels and zirconium alloys for structural materials in nuclear power plants, and long-range ordered alloys in the (Ni, Co, $Fe)_3V$ systems for use in non-nuclear power plants.

32219 **Systematics of the intra-rare-earth binary alloy systems.** Gschneidner, K.A. Jr. (Ames Lab., IA, USA; Iowa State Univ. of Science and Technology, Ames, USA. Dept. of Materials Science and Engineering). *Journal of the Less-Common Metals;* **114**: No. 1, 29-42(2 Dec 1985).

A generalized phase diagram for the trivalent intra-lanthanide and yttrium-lanthanide binary alloys is proposed. This single diagram represents a total of 91 phase diagrams. A method of calculating unknown diagrams is described. These 91 diagrams can be classified into 13 types of phase diagrams, examples of 11 types are known, and a hypothetical diagram is calculated for the other two types. The lattice spacings of these intra-rare-earth alloys generally exhibit positive deviations from Vegard's law if the end-members have the same structure. This is consistent with the second order elasticity model explaining deviations from Vegard's law. Both positive and negative deviations are found in the light lanthanide-heavy lanthanide alloys were the end-members always have different structures. These behaviors are explained on the basis of the d occupation number which decreases from the light lanthanides to the heavy lanthanides.

32220 **Mass transfer and electrochemical kinetic interactions in localized pitting corrosion.** Gaudet, G.T.; Mo, W.T.; Isaacs, H.S.; Newman, R.C.; Hatton, T.A.; Tester, J.W. New York, NY; American Institute of Chemical Engineers (1985). 44p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Simulated pitting corrosion of stainless steel under potentiostatic and galvanostatic conditions is interpreted in terms of a one-dimensional, transient diffusion model to decouple the mass transfer and electrochemical kinetic effects. The effects of concentration and viscosity on the diffusivity and the effects of electromigration are included in the analysis.

32221 **Procedures for a modified tritium trick-helium doping and residual tritium analysis of vanadium alloys.** Ramey, D.W.; Braski, D.N. (Oak Ridge National Lab., TN). *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms;* **B10/11**: 976-980(1985). (CONF-841117—Pt.2). Contract AC05-84OR21400.

From 8. conference on the application of accelerators in research and industry; Denton, TX, USA (12 Nov 1984).

A modified tritium trick technique was used to implant three levels of ^3He in V-15% Cr-5% Ti and Vanstar-7 specimens. The modifications include: (1) wrapping of the specimens with tantalum foil to minimize oxygen contamination and (2) tritiation treatment at 400°C to prevent vanadium tritide formation and to produce a ^3He bubble distribution similar to that produced during elevated temperature irradiation. Preliminary results show that both modifications were successful. An electrochemical dissolution technique was developed to determine residual tritium levels in the vanadium alloys. Measured residual tritium levels after tritium removal were in the range of 500 to 1400 μCi/g (0.88 to 2.99 appm tritium in the alloy). Tritium solubilities in the alloys were calculated from the tritium decay time and the measured ^3He content. Vanstar-7 specimens consistently absorbed about half as much tritium, and subsequently contained half as much ^3He as V-15% Cr-5% Ti. Implanting ^3He in vanadium alloys via the tritium trick offers a convenient technique to study the mechanism of helium embrittlement without irradiation and should provide a rapid screening method to help develop embrittlement-resistant vanadium alloys.

32222 **Cryogenic materials for high field superconducting magnets.** Morris, J.W. Jr.; Dalder, E.N.C. (Lawrence Berkeley Lab., CA, USA). *R and D, Kobe Seiko Giho;* **34**: No. 3, 1-20(Jul 1984).

This paper reviews needs and current research relevant to materials for high field superconducting magnets. The review is written from an American perspective, but recognizes that much of the most important current research is done interactively in parallel programs in the United States and Japan. High field superconducting magnets are used principally for magnetic fusion energy devices and accelerators for research in particle physics. The advance of both technologies has increased the field, size and performance requirements of such magnets. More stringent requirements are expected in the future. The needed materials include both structural materials for the magnet case and support structure and high field superconducting wire for the magnet winding. Current research on both classes of materials is briefly described and discussed.

32223 **Effect of Grande Ronde basalt groundwater composition and temperature on the corrosion of low-carbon steel in the presence of basalt-bentonite packing.** Anantatmula, R.P. (Rockwell Hanford Operations, Richland, WA). pp 273-278 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-77RL01030.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Basalt Waste Isolation Project (BWIP) is being conducted for the US Department of Energy (DOE) by Rockwell Hanford Operations. The effect of Grande Ronde Basalt groundwater composition and temperature on the corrosion rate of American Iron and Steel Institute (AISI) 1020 steel in basalt-bentonite packing was investigated as part of the Containment Materials Testing program of the BWIP. The studies were based on a Plackett-Burman statistical sceening design, the purpose of which is to identify the important variables affecting a process and to use this information to guide future investigative efforts. For the present studies, four anions (Cl^-, F^-, SO_4, and CO_3^- and temperature were selected as the initial variables affecting corrosion. A minimum and a maximum value was chosen for each variable. The minimum value was O mg/L for the anions and 100°C for the temperature. The maximum values were 780, 76, 576, and 120 mg/L respectively, for Cl^-, F^-, SO_4^-, and CO_3^-, and 250°C for the temperature. Analysis of the data revealed that temperature is the only statistically significant variable affecting corrosion of low-carbon steel in basalt groundwater in the composition range of the anions tested. Increasing the temperature from 100°C to 250°C decreased the total corrosion by a factor of seven to ~50 mg/dm² independent of the water composition. This is attributed to a strongly adherent layer of iron- and silicon rich clay on the surface of the steel formed by a reaction of the steel surface with the packing material as observed in previous studies.

32224 **Corrosion of candidate iron-base waste package structural barrier materials in moist salt environments.** Westerman, R.E.; Pitman, S.G. (Pacific Northwest Lab., Richland, WA). pp 279-285 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Mild steels are considered to be strong candidated for waste package structural barrier (e.g., overpack) applications in salt repositories. Corrosion rates of these materials determined in autoclave tests utilizing a simulated intrusion brine based on Permian Basin core samples are low, generally <25 μm (1 mil) per year. When the steels are exposed to moist salts containing simulated inclusion brines, the corrosion rates are found to increase significantly. The magnesium in the inclusion brine component of the environment is believed to be responsible for the increased corrosion rates. 1 ref., 4 figs., 3 tabs.

32225 **Corrosion behavior of carbon steels under tuff repository environmental conditions.** McCright, R.D.; Weiss, H. (Lawrence Livermore National Laboratory, CA). pp 287-294 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract W-7405-ENG-48.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Carbon steels may be used for borehole liners in a potential high-level nuclear waste repository in tuff in Nevada. Borehole liners are needed to facilitate emplacement of the waste packages and to facilitate retrieval of the packages, if required. Corrosion rates of low carbon structural steels AISI 1020 and ASTM A-36 were determined in J-13 well water and in saturated steam at 100°C. J-13 well water is representative of water which has percolated through the tuff horizon where the repository would be located. Tests were conducted in air-sparged J-13 water to attain stronger oxidizing conditions. a limited number of irradiation corrosion and stress corrosion tests were performed. Chromium-molybdenum alloy steels and cast irons were also tested. These materials showed lower general corrosion but were susceptible to stress corrosion cracking when welded. 4 refs., 7 tabs.

32226 **Test methods to predict long-term corrosion of container materials in repositories.** Merz, M.D.; Wang, R. (Pacific Northwest Lab., Richland, WA). pp 767-774 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

MCC test methods in support of basalt, salt and tuff repositories are described. The methods consist of three general corrosion tests for basalt, two general corrosion tests and three stress corrosion tests for salt, and two general corrosion tests for tuff. The tests encompass the various conditions that are expected in the different repositories. A summary is provided of experimental activities of the MCC, and detailed results of MCC 105.1 Test Method for Long Term General Corrosion in a Basalt Repository (Static System) for standaridized, benchmark conditions are presented. A summary of the statistical treatment of data is provided with examples of confidence intervals and the dependence of number of test vessels. The total relative standard deviation for the mean corrosion penetration rate was 11.4% for a mean corrosion penetration rate of 0.0244 mm/yr for 120 d tests at 100°C.

32227 **(Y/TR—86/6) Position-resolving x-ray diffractometry.** (Oak Ridge Y-12 Plant, TN (USA); Technische Univ., Vienna (Austria)). [1986]. Contract AC05-84OS21400. Translation source information not available . 113p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86010270.

A technique is described which provides a position-resolving x-ray fine-structure analysis based on the application of image reconstruction from projections. The additions to the conventional counter tube interference goniometer required for such measurements are a scanning unit and a micro-computer. Instead of the customary counter tube it is preferable to use a position-sensitive x-ray detector. The scanning unit provides for translational and rotational motions of the specimen. The specimen is moved in step increments past an x-ray beam which is defined by a strip-shaped slit arrangement, and a deflection line is measured, recorded, and stored in the computer at each step. The diffraction line corresponding to each point of the specimen is then calculated from many such projections, recorded for various directions. The resolution attainable lies in the range of 0.1 to 1 mm. In principle there is no limitation to the size of the speciments. However, with the customary x-ray apparatus there is a limitation to between about 1 and 3 cm diameter. 24 refs., 62 figs.

3602 Ceramics, Cermets, And Refractories

REFER ALSO TO CITATION(S) 31295, 31317, 31477, 31566, 31837, 32218, 32476, 33396, 33440

32228 (CONF-860495—7) **Characterization of hard mono-nitride and -carbide titanium and zirconium coatings on high speed steel cutting tool inserts.** Fenske, G.; Kaufherr, N.; Albertson, C.; Mapalo, G.; Nielsen, R.; Kaminsky, M. (Argonne National Lab., IL (USA); Borg-Warner Corp., Des Plaines, IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 20p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010516.

From International conference on metallurgical coatings; San Diego, CA, USA (7 Apr 1986).

Hard mono-nitride and carbide coatings of Ti and Zr, deposited on high speed steel (T-15) cutting tool inserts by two different techniques (Activated Reactive Evaporation (ARE) - UCLA, and High Rate Reactive Sputtering - Borg-Warner), have been examined by several microscope and spectroscopic techniques. Information about the chemical composition of the coatings and their spatial distribution was obtained through scanning Auger microanalysis with sputter depth profiling, and with the aid of energy dispersive x-ray analysis. Optical microscopy, scanning electron microscopy (SEM), and profilometry provided information on film thickness, film morphology, and the surface topography of coated and uncoated T-15 inserts. Transmission electron microscopy (TEM) of transverse sections of coated T-15 samples yielded information about the microstructure of the coating, and of the coating/substrate interface region (e.g., grain size, preferred orientation).

32229 (FRNC-TH—2269) **Brittle rupture and resistance to thermal shocks of structural ceramics.** Glandus, J.C. (Limoges Univ., 87 (France)). Dec 1985. 276p. (In French). NTIS (US Sales Only), PC A13/MF A01. File Number DE86752157.

The present work is a contribution to a quantitative interpretation of thermal shock of ceramics to cold water. Materials used for the study are: Alumina Al23, Silicon nitride NR115, vitreous silica Pursil K, silicon oxynitride, sintered aluminium nitride and also silicon carbide and zirconium oxide. Elastic moduli are measured at medium frequency and an original method by disk vibrations is developed. Fracture toughness is examined and values obtained by different methods are discussed. Thermal shock is examined and a nondestructive method is presented. Influence of microstructural parameters and of temperature on mechanical properties are studied and consequences on resistance to thermal shocks are drawn. Importance of elaboration conditions on mechanical properties are underlined.

32230 (INIS-BR—462) **Proceedings of the 6. Brazilian Congress on Engineering and Materials Science.** (Pontificia Univ. Catolica do Rio de Janeiro (Brazil)). 1984. 399p. (In Portuguese and English). (CONF-8412102—). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009.

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

Some papers are presented on phase transformation, fabrication, mechanical properties, and instrumentation of ceramic nuclear materials.

32231 (INIS-BR—462, pp 347-350) **Preparation of alumina - β'. 2. Effects of the impurities on the ionic conductivity.** Casarini, J.R.; Souza, D.P.F. (Sao Carlos Univ., Brazil. Dept. de Engenharia de Materiais). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

Sinterized samples of alumina - β' with 98% of theoretical density are obtained from alumina powder ($\beta + \beta'$) with composition of 8.85% Na_2O + 0.75% Li_2O + 90.40% Al_2O_3. The concentration of these impurities is controled by the carbothermic reduction at 1300°C of aluminium hydroxide used as raw material. The final product of the reduction process is aluminium oxide. The conductivity measurement of the sodium beam is done in samples with (2.5 x 1.0 x 0.3) cm using synchronous phase amplification.

32232 (INIS-BR—462, pp 343-346) **Preparation of alumina-β'. 1. Effect of the raw material purity on the phase transformation.** Casarini, J.R.; Souza, D.P.F. (Sao Carlos Univ., Brazil. Dept. de Engenharia de Materiais). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

Alumina - ($\beta + \beta'$) in powder, with composition of 8.85% Na_2O + 0.75% Li_2O + 90.40% Al_2O_3 is obtained using the zeta process. The phase transformation $\beta \rightarrow \beta'$ can be seen with powder X-ray diffraction. It was observed that the efficiency of the transformation is related to the processing and purity of the raw material. Impurities such as Ca and Si make difficult the phase transformation $\beta \rightarrow \beta'$.

32233 (INIS-BR—465) **Solid ionization chamber.** Freitas, M. de. (Sao Paulo Univ., Sao Carlos (Brazil). Inst. de Fisica e Quimica). 1984. 65p. (In Portuguese). NTIS (US Sales Only), PC A04/MF A01. File Number DE86701933.

Assuming electron and hole bands and independent recombination centers or both carries, Hughes and Sokel calculated the characteristics and charge distributions for lead oxide, PbO, under irradiation. The calculation also included the diffusion current and it was asserted that such a current was important in some aspects. The characteristic for PbO was recalculated without the diffusion component and essentially the same results were obtained. Also, approximations were derived for low and high fields. Next, assuming equal parameters for both carriers (that is, equal mobilities, trapping times, recombination rates and density of trap), characteristics were obtained for 18 combinations of three conveniently defined set of parameters. Low and high field approximation were also derived for this case.

32234 (KFK—4009) **Wear-resistant materials based on boron carbide.** Lange, D. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Maschinenbau). Dec 1985. 203p. (In German). NTIS (US Sales Only), PC A10/MF A01. File Number DE86752022.

This investigation looks for possibilities of using boron carbide in wear resistant materials. Therefore it is necessary to increase the strength and to reduce the brittleness, which can be obtained by formation of numerous phase and grain boundaries. Investigations of the phase relations show that there is no coexistence between boron carbide and binder metals such as Fe, Co or Ni. Two phase materials containing boron carbide and any metal are metastable. Silicon wets boron carbide very well. There is a phase equilibria between silicon and a boron carbide-silicon solid solution. This is one of the important results of the investigation, because now it is possible to produce a thermodynamic stable material by infiltration of a boron carbide body with liquid silicon. Boron carbide is coexistent with several refractories such as SiC, Al_2O_3, LaB_6 and some borides of the transition metals (TiB_2, ZrB_2, HfB_2 etc.) Materials containing these phases have a great amount of phase- and grain boundaries. The microstructure and properties of the materials depend on the way of production. The influence of the character of the additional phase (metallic, non-metallic or ceramic) on the properties is modest. For densification of these materials a special method of hot pressing was developed. Therewith it is possible to produce simple parts in an easy way. The hardness of the materials is approximately 3500 HV2, the bending strength is about 700-900 MPa. Wear properties were examined on some examples of application. (orig./IHOE).

32235 (LA-UR—86-1276) **Ceramics for fusion applications.** Clinard, F.W. Jr. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 15p. (CONF-860608—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010181.

From World congress on high tech ceramics: electronic, engineering, nuclear, biomedical research and applications in focus; Milan, Italy (23 Jun 1986).

Ceramics are required for a variety of uses in both near-term fusion devices and in commercial powerplants. These materials must retain adequate structural and electrical properties under conditions of neutron, particle, and ionizing irradiation; thermal and applied stresses; and physical and chemical sputtering. Ceramics such as Al_2O_3, $MgAl_2O_4$, BeO, Si_3N_4 and SiC are currently under study for fusion applications, and results to date show widely-varying response to the fusion environment. Materials can be identified today which will meet initial operating requirements, but improvements in physical properties are needed to achieve satisfactory lifetimes for critical applications.

32236 **(ORNL/Sub—85-69611/1) Slurry erosion of WC-Co alloys and selected ceramics.** (Battelle Columbus Labs., OH (USA)). Apr 1986. Contract AC05-84OR21400. 151p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86010418.

This report describes the erosion of WC-Co cermets and ceramics in a slurry test simulating valves and pumps operating in coal-derived slurries. For a WC-Co cermet having a carbide grain size of approximately 1μm, the erosion rate decreased with increasing alloy hardness and decreasing cobalt volume fraction. Modes of material removal contributing to the overall erosion loss were used to formulate a semi-empirical model. The effect of a limited change in carbide grain size was also investigated, and the model was shown capable of accurately predicting the change in erosion rate. The velocity dependences of erosion of the cermets representing the range of properties studied were different, suggesting that different mechanisms of material removal predominated in the low- and high-binder materials. A series of ceramics exhibited erosion behaviors which could be categorized either as intergranular (brittle) or as transgranular/microflaking (ductile).

32237 **(SAND—85-2412C) X-ray line profile analysis of shock-modified compounds.** Morosin, B.; Graham, R.A.; Zhang, Y.; Stewart, J.M. (Sandia National Labs., Albuquerque, NM (USA); Maryland Univ., College Park (USA). Dept. of Chemistry). 1986. Contract AC04-76DP00789. 8p. (CONF-860616—7). NTIS, PC A02/MF A01; GPO Dep. File Number DE86003454.

From International symposium on intense dynamic loading and its effects; Beijing, China (3 Jun 1986).

The overall assessment revealed by the extensive studies show that large plastic deformation as evidenced by residual lattice strain is introduced at peak pressures of 7.5 GPa or lower. For various refractory materials, both coherent domain size and residual lattice strain depend strongly on shock conditions (pressure and temperature) and on specific material properties. There is evidence for defect configurations which differ from those produced by more conventional methods. The high residual strain values resulting from the large intense plastic deformation on these normally brittle refractory materials are more typical of those determined in heavily cold worked metals. The behavior is consistent with the unusual nature of the shock deformation process. Such shock-modified materials have been shown to exhibit increased chemical reactivity in a manner that should influence material processing procedures.

32238 **Origin of the anisotropic upper critical fields in single crystals of superconducting rare-earth ternary borides.** Shenoy, G.K.; Malik, S.K. (Materials Science and Technology Division, Argonne National Laboratory, Argonne, Illinois 60439). *Physical Review [Section] B: Condensed Matter;* **33**: No. 9, 6132-6134(1 May 1986). Contract W-31-109-ENG-38.

Upper-critical-field [H/sub c/2(T)] measurements in single-crystal $ErRh_4B_4$ have revealed a large anisotropy. We show that this anisotropy is a consequence of the crystalline electric fields (CEF's) acting on the Er^{3+} ion which make the exchange field acting on the conduction electrons anisotropic. A full calculation based on Werthamer-Helfand-Hohenberg theory with the inclusion of CEF's completely explains the observed anisotropy in H/sub c/2(T) for $ErRh_4B_4$. In addition, the critical-field measurements in $ErRh_4B_4$ provide a means for the reliable determination of the magnitude and the sign of the exchange constant J/sub s/f.

32239 **Anisotropic magnetoresistance in a Fermi glass.** Ovadyahu, Z. (Brookhaven National Laboratory, Upton, New York 11973; Physics Department, Ben-Gurion University of the Negev, Beer-Sheva, Israel 84120). *Physical Review [Section] B: Condensed Matter;* **33**: No. 9, 6552-6554(1 May 1986). Contract AC02-76CH00016.

Insulating thin films of indium oxide exhibit negative, anisotropic magnetoresistance. The systematics of these results imply that the magnetoresistance mechanism may give different weight to the distribution of the localization lengths than that given by the hopping conductivity.

32240 **Influence of superconductivity on magnetic exchange interactions.** Dunlap, B.D.; Fedro, A.J. (Argonne National Laboratory, Argonne, Illinois). *Journal of Low Temperature Physics;* **62**: No. 5, 375-383(1 Mar 1986).

Using the formulation due to Fedro and Robinson of magnetic exchange in the presence of superconductivity, the mean field magnetic interaction energy has been calculated for rare earth (RE) ions in the $RERh_4B_4$ lattice. It is shown that increasing the strength of the superconducting interaction relative to the magnetic interaction results in a decrease of ferromagnetic coupling, and in some cases may drive ferromagnetic systems into antiferromagnetism.

32241 **Comparison of the Contact stress and friction behavior of SiC and ZrO_2 materials.** Lindberg, L.J.; Richerson, D.W. (Garrett Turbine Engine Co., Phoenix, AZ 85010). pp 1059-1066 of Proceedings of the ninth annual conference on composites and advanced ceramic materials;. Columbus, OH; American Ceramic Society, Inc. (1985). (CONF-850122—).

From 9. annual conference on composites and advanced ceramic materials and workshop on testing methods for ceramic matrix composites; Cocoa Beach, FL, USA (20 Jan 1985).

Studies were performed to further elucidate the friction and contact- stress characteristics of structural ceramic materials. New data for fully stabilized and partially stabilized zirconia ceramics are compared with prior test results for sintered SiC. The comparison provides further evidence that the high temperature friction characteristics of sinstered SiC are strongly influenced by the presence of a viscous surface layer. The results also show that a ceramic material with lower coefficient of friction and higher fracture toughness has increased resistance to strength-reducing surface damage due to contact stress.

32242 **Irradiation-induced reduction of microcracking in zirconolite.** Clinard, F.W. Jr.; Tucker, D.S.; Hurley, G.F.; Kise, C.D.; Rankin, J. (Los Alamos National Lab., NM). pp 663-670 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

^{238}Pu-substituted zirconolite ($CaPuTi_2O_7$) was stored near ambient temperature for 231 days, equivalent to an alpha decay dose of $3.1x10^{25}$ α/m^3 or $3x10^5$ years of storage time for SYNROC ceramic nuclear waste. periodic indentation testing showed that hardness was decreased by alpha decay-induced conversion to the metamict state, while fracture toughness and resistance to cracking were increased, apparently as a consequence of the formation of a heterogeneous microstructure. These results imply improved stability of this nuclear waste phase as a result of self-irradiation damage. 21 refs., 4 figs.

32243 **Self-radiation damage in actinide host phases of nuclear waste forms.** Weber, W.J.; Wald, J.W.; Matzke, J. (Pacific Northwest Lab., Richland, WA; Commission of the European Communities, Karlsruhe, Germany). pp 679-686 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Three crystalline ceramic materials, which occur as host phases for the long-lived actinides in many nuclear waste formulations, were doped with Cm-244, and the effects of self-radiation damage from alpha decay on microstructure and physical properties were investigated. The irradiation-induced microstructure consisted of individual amorphous tracks from both the alpha-recoil particles and the spontaneous fission fragments. The eventual overlap of the tracks at higher doses leads to a completely amorphous state. This radiation-induced amorphization process results in measured increases in vomume, leachability, and stored energy. thermal recovery of the radiation-induced swelling and amorphization occurs with full recrystallization to the initial structures. 21 refs., 5 figs., 2 tabs.

3603 Composite Materials

REFER ALSO TO CITATION(S) 31761, 32178

32244 (AD-A—164095/2/XAB) Plasma joining of metal-matrix composites. Interin report, October-November 1985. Reynolds, G.H.; Yang, L. (MSNW, Inc., San Marcos, CA (USA)). Dec 1985. 14p. NTIS, PC A02/MF A01.

Aluminum-reactive metal-matrix alloys for Al-SiC composite filler metals are described. Preliminary process modeling studies on constituent vaporization effects, thermochemical stability of surface oxide films, and dissolved gas evolution in-plasma are described.

32245 Ambient-pressure superconductivity at the highest temperature (5 K) observed in an organic system: β-(BEDT-TTF)$_2$AuI$_2$. Wang, H.H.; Beno, M.A.; Geiser, U.; Firestone, M.A.; Webb, K.S.; Nunez, L.; Crabtree, G.W.; Carlson, K.D.; Williams, J.M.; Azevedo, L.J. (Argonne National Lab., IL). *Inorganic Chemistry;* **24**: No. 16, 2465-2466(31 Jul 1985). Contract W-31-109-ENG-38.

The occurrence of a superconducting state in β-(ET)$_2$AuI$_2$ was detected by rf penetration depth measurements at ambient pressure and at various applied magnetic fields, similar to measurements previously reported for the I_3^- and IBr_2^- derivatives. The change in resonant frequency as a function of temperature at zero applied magnetic field was determined for a sample consisting of three relatively large single crystals. This sample gave an apparent onset temperature for bulk superconductivity (T/sub c/) of 4.97 +/- 0.06 K, which is the highest T/sub c/ yet observed at ambient pressure for an organic superconductor. 21 references, 1 figure.

3604 Polymers And Plastics

REFER ALSO TO CITATION(S) 33438

32246 (DOE/ER/45114—2) Statistical mechanics of polymer systems. Progress report, September 1, 1985-August 31, 1986. Kovac, J. (Tennessee Univ., Knoxville (USA). Dept. of Chemistry). 1 May 1986. Contract FG05-84ER45114. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010292.

In the original proposal, three areas of research were outlined: (1) development of reasonable, but mathematically tractable models for isolated polymer chain dynamics using projection operator techniques; (2) study of the effect of entanglements on the dynamics of polymer chains by means of computer simulation; and (3) nonequilibrium thermodynamic and statistical mechanical theories of the glass transition. In the second year of the grant we have again focussed almost all our efforts on the computer simulation work. This effort has been rewarded by a major advance, the inclusion of nearest neighbor interactions in the dynamic simulation algorithm. This has allowed us to study solvent effects on single chain dynamics. A wide range of interestig problems in concentrated polymer systems, such as mutual diffusion, polymer-polymer welding and phase separation in block copolymers can be studied using this model. Results of the computer simulation studies of the previous year are summarized.

32247 (DOE/ER/45123—2) Fundamental studies of elastomers. Annual progress report, June 15, 1985-March 21, 1986. Eichinger, B.E. (Washington Univ., Seattle (USA). Dept. of Chemistry). 1986. Contract FG06-84ER45123. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010438.

The progress report for the first year of this grant described computer simulations on random networks, shape distributions, synthesis of chelation networks, and coordination polymers. Work has continued in all four of these areas in the past year. Highlighted here is the work that we have been doing on computer simulations of random cross-linking, wherein radiation damage is a very important feature of the chemical reactions that occur. Furthermore, we have made a coordination compound which looks quite encouraging at the present time. Our efforts on chelation networks are proceeding and we are developing very promising methods for creating the polymers that we need for these studies.

32248 (NUREG/CR—4543) First results from electron-photon damage equivalence studies on a generic ethylene-propylene rubber. Buckalew, W.H. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 42p. (SAND—86-0462). NTIS, PC A03/MF A01 - GPO. File Number TI86010638.

As part of a simulator adequacy assessment program, the relative effectiveness of electrons and photons to produce damage in a generic ethylene propylene rubber (EPR) has been investigated. The investigation was limited in extent in that a single EPR material, in three thickness, was exposed to Cobalt-60 photons and three electron beam energies. Basing material damage on changes in the EPR mechanical properties elongation and tensile strength, we observed that EPR damage was a smoothly varying function of absorbed energy and independent of irradiating particle type. EPR damage tracked equally well as a function of both incident particle energy and material front surface dose. Based on these preliminary data, we tentatively concluded that a correlation between particle, particle energy, and material damage (as measured by changes in material elongation and/or tensile strength) has been demonstrated. 14 figs.

32249 Neutron induced conductivity in trans-polyacetylene. Butler, M.A.; Ginley, D.S.; Bryson, J.W. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Physics Letters;* **48**: No. 19, 1297-1299(12 May 1986). Contract AC04-76DP00789.

Neutron induced conductivity is reported for the first time in an organic conductor. The induced conductivity is linear in total neutron flux over several decades and Seebeck measurements indicate that the conductivity is p type. Optical measurements show that acetonitrile plays an important role in the conductivity changes. The implication of these results for conduction mechanisms in polyacetylene is discussed. These results demonstrate a new method for producing uniform low doping in organic conductors and a potential mechanism for a new, fast neutron dosimetry.

3606 Other Materials

REFER ALSO TO CITATION(S) 31559, 31692, 32041, 32087, 32178, 32361, 32414, 32889, 32892, 32894, 32896, 32897, 33245

32250 (CONF-860418—5) Experimental alteration of basalt glass applied to the alteration of nuclear waste glass. Byers, C.D.; Ewing, R.C.; Jercinovic, M.J. (Argonne National Lab., IL (USA); New Mexico Univ., Albuquerque (USA). Dept. of Geology). 1986. Contract W-31-109-ENG-38. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010520.

From 88. annual meeting of the American Ceramic Society; Chicago, IL, USA (27 Apr 1986).

The main objective of the experiments was to produce in the laboratory an altered basalt glass similar to basalt glass altered in a natural environment. This objective has been accomplished with a very good correlation between the observed alteration of basalt glass in a natural environment with that in the laboratory. The formation of the amorphous hydration layer, smectite, analcime, calci-

um carbonate, and thomsonite all have been observed in natural glass samples that have undergone palagonitization. The SRL 165 glass reacts to a greater extent than the synthetic basalt glass under the same conditions. The alteration of SRL 165 glass produced a smectite clay, analcime, and gyrolite similar to that produced by the synthetic basalt glass.

32251 **(CONF-860445—11) Elastic properties of $LaNbO_4$.** Nevitt, M.V.; Chan, S.K.; Grimsditch, M.H.; Fisher, E.S. (Argonne National Lab., IL (USA)). Apr 1986. Contract W-31109-ENG-38. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010494.

From Materials Research Society spring meeting; Palo Alto, CA, USA (15 Apr 1986).

We have measured longitudinal and shear velocities in a number of directions in a single crystal of $LaNbO_4$ and, using these data in a computer-based nonlinear least-squares fit to the Cristoffel relations, we have determined the thirteen elastic constants. Longitudinal and transverse velocities for various directions in the crystal have been calculated. We have shown that the elastic anomaly associated with the soft acoustic phonon generates an anisotropy in the transverse shear mode in a confined region of solid angle centered on the basal plane. The soft direction is believed to result from the complex interplay of bond-bending and bond-stretching forces in the crystal lattice.

32252 (INIS-BR—462, pp 76-80) **Identification of microstructures.** Padilha, A.F.; Ambrozio Filho, F. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The identification of phases in a material can require the utilization of several techniques. The most used technique and discussed are: optical microscope, scanning electron microscope, transmission electron microscope, X-ray diffraction and 'in-situ' chemical analysis of the phases. The microstructures were classified, according to the size and phase volumetric fraction, in four types. For each type the most appropriate techniques for identifying the phases are discussed.

32253 (INIS-BR—462, pp 270-274) **Study of irradiation damage by fast neutrons in samples of Portland cement.** Lucki, G.; Rosa Junior, A.A. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The effect of neutron irradiation in samples of Portland cement was evaluated, using the resonance frequency method and pulse velocity of ultra-sound techniques. The samples were divided in three groups: 1) monitoring samples; 2) samples submitted to gamma heating; 3) irradiated samples. In the sample preparation, Portland Santa Rita CP 320 cement was used, and water-cement rate of 0.40 l/Kg. The irradiation was done in the research reactor IEA-R1, at IPEN - CNEN/SP, with an integrated flux of 7.2 x 10^{18}n/cm^2 (E approx. 1 MeV). Some damage was detected, due to the neutron flux, and by the thermal effect of gamma heating.

32254 **(INIS-BR—463) Two interesting cases in spatial charge movement.** Novellino, R.A. (Sao Paulo Univ., Sao Carlos (Brazil). Inst. de Fisica e Quimica). 1983. 77p. (In Portuguese). NTIS (US Sales Only), PC A05/MF A01. File Number DE86701937.

The relation between current and voltage in a dielectric under radiation is obtained, assuming only one carrier to be mobile, recombination and injection of the mobile charge from the electrode. For this last boundary condition a constant charge density at the electrode-dielectric interface was chosen. The other problem treated is a generalization of the classic transient problem studied by Many-Rakavy, using the constant charge density boundary condition. Analytic solutions were obtained during the first transit time and computed ones for larger times. Some attention was given to the damped current oscilations approaching the steady state value.

32255 **(JINR—R-14-85-2) Neutron diffraction on a large block mosaic crystal.** Kim Chir Sen; Nitts, V.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1985. 15p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701938.

Submitted to the journal Phys. Status Solidi.

The neutron diffraction by the mosaic single crystal with size of crystallites sufficient to achieve the primary extinction saturation is considered. Two cases where the proportionality between the reflection intensity and the structure amplitude is performed are analysed. Such a dependence is convenient for structure investigations. The difficulties connected with the accounting of the extinction are eliminated considerably.

32256 **(LA-UR—86-1180) Pyrolyzed macrocycle/carbon blends for advanced electrocatalysts.** Vanderborgh, N.E.; Rieke, P.C. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 4p. (CONF-8606113—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010172.

From Carbon conference; Baden-Baden, F.R. Germany (30 Jun 1986).

Pyrolysis of metallated macrocycle compounds involves a vapor phase condensation to form a solid, condensation product that is carbonaceous and electronically conductive. Reaction of these vapors with hot carbon surfaces permits condensation on these surfaces that prepares active electrocatalytic carbons. The role of the metal ion in these processes is not clear, although the chelate clearly acts to carry the metal into the vapor phase. Rapid peroxide decomposition results only with the composite (carbon plus chelate) char. Thus these modified surfaces add the necessary peroxide reactivity to carbon for high oxygen electroreduction rates.

32257 **(ORNL/Sub—84-9009/1) Effective conductivity of aging polyurethane foam.** Glicksman, L.R.; Ostrogorsky, A.G.; Chiappetta, S. (Massachusetts Inst. of Tech., Cambridge (USA)). Mar 1986. Contract AC05-84OR21400. 64p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86008939.

An experimental technique was developed to measure the permeability of the cell walls to air components. Cell walls obtained from large bubbles were used as samples. The large bubbles are found on the surface of free rise foam. Once cell wall permeability and cell geometry are known, the foam effective diffusion coefficient can be computed from a model developed earlier. An experimental technique was also developed to measure the effective permeability of the foam. Data were taken with N_2, O_2 and CO_2 at different temperatures. The permeability of the three gases vary in the ratio 1:4:25, respectively. To determine if steady state gas partial pressure is reached in a sample, graphs similar to Heisler Charts were developed. To accelerate the data taking process special charts utilizing the analytical solution of the transient transfer process were made. These graphs enable data to be taken before the steady state profile is completely developed. Two simple laboratory tests were developed to measure the effectiveness of the diffusion barriers. A test cell was designed to measure the leakage rate through the open paths at the foam-foil interface. To be able to detect the open paths a simple dye technique was developed. It was found that most of the tested samples with foil on both sides have open paths at only one interface. On the other interface an open shear layer 1 to 2 mm below the interface was detected.

32258 **(SAND—85-2388C) Ion beam channeling in superlattices.** Chu, W.K.; Allen, W.R.; Picraux, S.T.; Ellison, J.A. (North Carolina Univ., Chapel Hill (USA). Dept. of Physics and Astronomy; Sandia National Labs., Albuquerque, NM (USA); New Mexico Univ., Albuquerque (USA). Dept. of Mathematics). 1986. Contract AC04-76DP00789. 5p. (CONF-860445—9). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010094.

From Materials Research Society spring meeting; Palo Alto, CA, USA (15 Apr 1986).

Ion beam channeling analysis has recently been applied to lattice strain measurements on strained-layer superlattices (SLS). In this review talk, we outline three different methods of strain measurement: axial dechanneling, angular scans, and planar resonance.

We describe the principles and illustrate them with examples; we also give a detailed theoretical treatment of the planar resonance effect in SLS's.

32259 **(SAND—86-0901C) Damage equivalence in the irradiation of silicon.** Lee, C.E.; Luera, T.F. (Technadyne Engineering Consultants, Albuquerque, NM (USA); Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 15p. (CONF-860420—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009852.

From Fast burst reactor workshop; Albuquerque, NM, USA (8 Apr 1986).

The radiation hardness parameter is evaluated for thirteen displacement kerma factors and twelve incident neutron energy-fluence spectral distributions. The integrals are performed interactively using an adaptive recursive Simpson integration technique in Turbo-Pascal which allows for any mixture of analytic and/or multigroup displacement kerma factors and spectral distributions. The radiation hardness parameter determined from a recent NJOY evaluation is compared with other known evaluations. The simulation fidelity, which depends on the ratio of hardness parameters in the operational environment to that for the simulation environment, is evaluated and compared for these spectra and models. Except for the 14 MeV spectra, the simulation fidelity of most models agree with the NJOY to within 10%. 15 refs., 6 tabs.

32260 **Oxygen isotope effect on the 889 cm^{-1} band in silicon.** Stein, H.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Physics Letters;* **48**: No. 22, 1540-1541(2 Jun 1986). Contract AC04-76DP00789.

Implantation studies with ^{16}O and ^{18}O isotopes have been used to evaluate a recent proposal that an 889 cm^{-1} absorption band in O-containing Si is produced by two oxygen atoms in a vacancy. The present isotope studies indicate that the 889 cm^{-1} mode is determined by a single oxygen atom bonded to Si. Thus, O-O interactions in the 889 cm^{-1} mode must be weak or nonexistent. Possible relationships of the 889 cm^{-1} band to oxygen-vacancy defects and thermal donors are considered.

32261 **Direct measurements of the velocity and thickness of "explosively" propagating buried molten layers in amorphous silicon.** Lowndes, D.H.; Jellison, G.E. Jr.; Pennycook, S.J.; Withrow, S.P.; Mashburn, D.N. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Applied Physics Letters;* **48**: No. 20, 1389-1391(19 May 1986). Contract AC05-84OR21400.

Simultaneous infrared (1152 nm) and visible (633 nm) reflectivity measurements with nanosecond resolution were used to study the initial formation and subsequent motion of pulsed KrF laser-induced "explosively" propagating buried molten layers in ion implantation-amorphized silicon. The buried layer velocity decreases with depth below the surface, but increases with KrF laser energy density; a maximum velocity of about 14 m/s was observed, implying an undercooling-velocity relationship of ~ 14 K/(m/s). Z-contrast scanning transmission electron microscopy was used to form a direct chemical image of implanted Cu ions transported by the buried layer and showed that the final buried layer thickness was <15 nm.

32262 **Equation of state and metallization of neon.** Boettger, J.C. (Theoretical Division, Los Alamos National Laboratory, University of California, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 10, 6788-6791(15 May 1986).

The linear combination of Gaussian-type orbitals technique is used to study the bulk properties, equation of state, and metallization pressure of Ne using the Kohn-Sham-Gaspar local-density approximation to density-functional theory. Unlike previous non-muffin-tin calculations for Ne, the present results are obtained for enough values of the lattice parameter to allow a careful determination of the equilibrium lattice constant, binding energy, and bulk modulus. Although the properties of Ne for pressures up to about 3 Mbar are in qualitative agreement with prior results, there are quantitative differences. In particular, as has been found in Li and Fe, the non-muffin-tin lattice constant is contracted relative to the muffin-tin result. The metallization pressure of Ne is determined to be 1.34 Gbar at a lattice constant of 2.32 a.u. as opposed to an earlier augmented plane wave prediction of 1.58 Gbar at 2.256 a.u. An explanation is given for what has been referred to as the "anomalously" large metallization pressure of Ne.

32263 **X-ray diffraction evidence of adatoms in the Si(111)7 x 7 reconstructed surface.** Robinson, I.K.; Waskiewicz, W.K.; Fuoss, P.H.; Stark, J.B.; Bennett, P.A. (AT&T Bell Laboratories, Murray Hill, New Jersey 07974). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 10, 7013-7016(15 May 1986).

Synchrotron radiation has been employed to measure 73 fractional-order surface Bragg reflections from Si(111)7 x 7. A novel data-filtering technique is introduced to address the question of which sites in the diamond lattice are filled and which are vacant at the surface. The analysis is greatly simplified because atomic displacements are systematically nulled. Our observations agree with the principle of a "stacking fault" under half the unit cell. Difference analysis then requires 12 adatoms and one vacancy to complete the structure.

32264 **Evaluation of the Stillinger-Weber classical interaction potential for tetragonal semiconductors in nonideal atomic configurations.** Dodson, B.W. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 10, 7361-7363(15 May 1986). Contract AC04-76DP00789.

A classical potential incorporating two- and three-body interaction terms has recently been introduced by Stillinger and Weber (SW) for simulation of the liquefaction transition of silicon. The equilibrium mechanical properties of this potential are determined and found to agree well with experimental values. The potential also seems to be adequate for problems involving computation of defect energies, such as the stability of strained-layer superlattice interfaces. However, inadequate treatment of configurations with low coordination number makes modeling of the epitaxial growth of (111) silicon impossible. Simple modifications of the SW potential form do allow for (111) epitaxial growth, but the earliest stages of growth then become unphysical.

32265 **Rhombohedral phase stability of the group-VA elements.** Chang, K.J.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94720 and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 10, 7371-7374(15 May 1986). Contract AC03-76SF00098.

The structural stability of the rhombohedral and simple cubic phases is studied for the group-VA elements. Using an ab initio pseudopotential total-energy method, the calculated phonon frequencies for the longitudinal acoustic mode at the corner of the simple-cubic Brillouin zone are found to soften. This suggests that all group-V elements are likely to form in the rhombohedral structure with respect to the simple cubic phase. At high pressures, the rhombohedral stability is diminished, causing a transition to the simple-cubic structure.

32266 **Photoemission study of Si(111)-Ge(5 x 5) surfaces.** Miller, T.; Hsieh, T.C.; Chiang, T.h. (Department of Physics and Materials Research Laboratory, University of Illinois at Urbana-Champaign, 1110 West Green Street, Urbana, Illinois 61801). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 10, 6983-6989(15 May 1986). Contract AC02-76ER01198.

Photoemission spectroscopy was used to study Si(111)-Ge(5 x 5) surfaces prepared by annealing Ge films deposited onto Si(111)-(7 x 7) substrates. The Si 2p core-level line shape was modified in going from (7 x 7) to (5 x 5) systems. By decomposing the spectra into bulk- and surface-shifted components the changes in line shape were identified as due to selective replacement of Si by Ge in different layers of the substrate, without any drastic change in the surface structure. The Ge 3d core-level line shape for the Si(111)-Ge(5 x 5) surface was also measured and compared with that for the Ge(111)-c(2 x 8) surface. These results are discussed in terms of models for the Si(111)-(7 x 7) structure. A surface state

was observed on the Si(111)-Ge(5 x 5) surface, which gave rise to a metallicklike Fermi edge in the angle-integrated spectra; a similar surface state was observed on the Si(111)-(7 x 7) surface but not on the Ge(111)-c(2 x 8) surface.

32267 **Effect of compressive uniaxial stress on the binding energies of D^- centers in Si:P and Si:As.** Oliveira, L.E.; Falicov, L.M. (Department of Physics, University of California, Berkeley, California 94720 and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review [Section] B: Condensed Matter;* **33**: No. 10, 6990-6997(15 May 1986). Contract AC03-76SF00098.

The binding energies of D^- states in P- and As-doped silicon crystals are calculated as functions of uniaxial compressive stress along the [100] direction within a variational scheme in the effective-mass approximation and with a Chandrasekhar-type variational function. A model Hamiltonian which takes into account valley-orbit corrections, electron-electron interaction, and stress effects is proposed. Our calculation shows that as the stress is applied, the outer electron orbital is driven readily into the two stress-deepened valleys, which leads to a strong decrease in the D^- binding energy. With further increase in stress, the inner electron orbital changes gradually from a function almost evenly distributed among the six conduction valleys into one in which the two stress-deepened valleys are dominant, and the D^- binding energy increases. Our results agree qualitatively with previous theoretical calculations and are in good agreement with far-infrared photoconductivity measurements in Si:P.

32268 **Enhancement of defect-induced Raman modes at the fundamental absorption edge of electron-irradiated GaAs.** Berg, R.S.; Yu, P.Y. (Department of Physics, University of California, Berkeley, California 94720; Center for Advanced Materials, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review [Section] B: Condensed Matter;* **33**: No. 10, 7349-7352(15 May 1986). Contract AC03-76SF00098.

Resonant Raman scattering in electron-irradiated GaAs has been studied. Enhancements in the scattering cross section of both intrinsic and defect-induced phonon modes at the fundamental absorption edge are reported. The experimental results are compared quantitatively with theory. A new scattering mechanism involving elastic scattering between electrons and defects is proposed to explain the resonance of the defect-induced Raman modes.

32269 **Phase transition studies of germanium to 1.25 Mbar.** Vohra, Y.K.; Brister, K.E.; Desgreniers, S.; Ruoff, A.L.; Chang, K.J.; Cohen, M.L. (Department of Materials Science and Engineering, Cornell University, Ithaca, New York 14853). *Physical Review Letters;* **56**: No. 18, 1944-1947(5 May 1986). Contract AC03-76SF00098.

New phase transitions in Ge were observed by energy-dispersive x-ray diffraction techniques for pressures up to 125 GPa (1.25 Mbar) as follows: the β-Sn structure to the simple hexagonal (sh) phase at 75 +- 3 GPa and to the double hexagonal close-packed structure (dhcp) at 102 +- 5 GPa. These are the highest pressures for which a crystalline structure change has been directly observed in any material by x-ray diffraction. Total-energy pseudopotential calculations predict 84 +- 10 GPa for the β-Sn to sh phase transition and 105 +- 21 GPa for sh to hcp (not dhcp) transition. The role of 3d core electrons in increasing the transformation pressures in Ge, as compared to Si, is emphasized.

32270 **Electronic and structural properties of a twin boundary in Si.** DiVincenzo, D.P.; Alerhand, O.L.; Schluter, M.; Wilkins, J.W. (Laboratory of Atomic and Solid State Physics and Materials Science Center, Cornell University, Ithaca, New York 14853). *Physical Review Letters;* **56**: No. 18, 1925-1928(5 May 1986).

A second-order twin boundary in Si, of the $\Sigma 9$ type, is investigated with first-principles density-functional theory and with an empirical tight-binding model. Of two proposed reconstructions studied, the one supported by recent experiment is energetically favored, with less bond stretching than the other. A conduction-band-edge interface electronic state associated with bond-angle strains is found. A phonon resonance, the interfacial analog of a Rayleigh mode, is predicted; Raman spectroscopy should be able to detect it.

32271 **Structural stability of phases of black phosphorus.** Chang, K.J.; Cohen, M.L. (Department of Physics, University of California, Berkeley, California 94720 and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review [Section] B: Condensed Matter;* **33**: No. 9, 6177-6186(1 May 1986). Contract AC03-76SF00098.

The pseudopotential method is used to examine the structural stability of high-pressure orthorhombic, rhombohedral (A-7), and simple cubic (sc) phases of black phosphorus. The calculated ground-state properties are in good agreement with the measured values for each phase. A total-energy study gives the orthorhombic phase as the most stable structure at low pressures. At higher pressures it transforms into the A-7 structure in agreement with experiment. At even higher pressure, the calculations indicate that the A-7 phase is stable with respect to the sc structure as is the case for other group-V elements. Measurements show that the sc phase is stable at 110 kbar at room temperature. This suggests that the calculated crystal energy for the A-7 phase is too low and it requires a finite energy shift. With an a priori energy shift, the transition pressure and volume are in good agreement with experiment. A possible source of this correction is the zero-point energy or temperature renormalization of the phonon frequencies caused by anharmonicity. The changes of the energy band structures and charge densities for the A-7 displacement and selected phonon frequencies are calculated.

32272 **Polarized neutron scattering from $CeCu_6Si_2$ in applied magnetic fields.** Uemura, Y.J.; Majkrzak, C.F.; Shirane, G.; Stassis, C.; Aeppli, G.; Batlogg, B.; Remeika, J.P. (Brookhaven National Laboratory, Upton, New York 11973). *Physical Review [Section] B: Condensed Matter;* **33**: No. 9, 6508-6511(1 May 1986).

Polarized neutron scattering from the heavy-fermion system $CeCu_6Si_2$ has been measured in horizontal magnetic fields in the range 0—20 kG. The scattering due to the electron excitation from up (down) (relative to the magnetic field) spin states to the down (up) spin states has been observed separately at T = 2.5 K. The difference between intensities for the two opposite spin-flip processes, I/sub arrow-uparrow-down/-I/sub arrow-downarrow-up/, agrees well with the value expected for a narrow resonance of width (HWHM) $\Gamma \sim 1$ meV at the Fermi level. This work introduces a new way of determining the very small energy scales for spin fluctuations in heavy-fermion systems.

32273 **Properties of furnace-annealed, high-resistivity, arsenic-implanted polycrystalline silicon films.** Schubert, W.K. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Materials Research;* **1**: No. 2, 311-321(Mar 1986).

The approach to equilibrium of the grain structure and electrical properties has been studied in high-resistivity, As-implanted polycrystalline silicon films on thermally oxidized silicon wafers. Thermal annealing parameters are found to be critical in determining the film sheet resistance. Results from spreading resistance analysis, secondary ion mass spectroscopy, and transmission electron microscopy indicate that As diffusion down the grain boundaries into the film leads to a large fraction of the As being left in inactive grain boundary sites. Reactivation of the As is negligible when processing temperatures are 900 °C or lower. A relatively simple diffusion model has been developed that can fit the As concentration profile over the entire film thickness. This makes the model applicable to normal integrated circuit processing conditions where film thickness effects and nonequilibrium dopant distributions are important.

32274 **Dynamic strain aging and serrated flow in MnO.** Goretta, K.C.; Routbort, J.L.; Bloom, T.A. (Materials Science and Technology Division, Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Materials Research;* **1**: No. 1, 124-129(Jan 1986). Contract W-31-109-ENG-38.

The effects of aging on the upper yield stress tau/sub up/ and serrated flow have been studied in MnO single crystals at 900°C for oxygen partial pressures p2 of 10^{-11} and 10^{-7} Pa. Aging initially increases tau/sub up/ as a consequence of segregation of aliovalent impurities to dislocations for both p2 values. For long aging times and p2 = 10^{-11} Pa, serrated flow accompanied by solute softening is observed. The data fit predictions of a Portevin—Le Chatelier model for serrations, but with impurity atmospheres causing softening instead of hardening. This is believed to result from changes in local defect equilibria caused by segregation of impurities with valences greater than two to dislocations.

32275 **Electron microscopy and krypton adsorption characterization of high-purity MgO powder.** Bretz, M.; Shastri, A.G.; Schwank, J. (Department of Physics, The University of Michigan, Ann Arbor, Michigan 48109). *Journal of Materials Research;* 1: No. 1, 114-119(Jan 1986). Contract FG02-84ER45059.

A promising method for the preparation of sizeable quantities of structurally well-defined, high-purity MgO powder is reported. The morphology and surface uniformity of the powder is comparable to that of MgO smokes but with narrow size distribution of particles. Sample characterization of these oxide powders is accomplished by combining structural TEM/STEM examination with krypton gas adsorption isotherms. The latter technique is sensitive to the presence of surface hydroxyl groups and of surface roughness on an atomic scale. High-resolution TEM indicates a perfect cubic morphology, intra-crystallite orientation, and dendritic sintering of cubes. In the STEM mode sharp convergent beam electron diffraction patterns are obtained, and in thick specimen regions Kikuchi lines appear, indicating the absence of crystal defects. After prolonged outgassing to remove surface hydroxyl groups, a krypton adsorption isotherm contains a near vertical submonolayer riser and second layer step along with partial wetting features near saturation. These near-ideal dendritic ceramic powders, therefore, provide a research bridge between single crystal surface studies and large-scale powder technology.

32276 **Transition metal ions in silicate melts. IV. Cobalt in sodium silicate and related glasses.** Nelson, C.; White, W.B. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Journal of Materials Research;* 1: No. 1, 130-138(Jan 1986). Contract AC02-76ER02754.

Optical measurements have been made on glasses quenched from a series of sodium silicate melts as well as germanate, borate, and phosphate liquids containing CoO. The spectral data show that Co^{+2} is the species stabilized in oxide melts heated in air. The observed bands occur at 2700-3850, 5750-7900, and 15,500-18,600 cm^{-1}. The independence of the optical parameters from melt composition and known melt structures, the high relative intensity of the high-frequency band, and the low calculated value of the Racah B parameter relative to the free ion value indicate that Co^{+2} forms a distinct tetrahedral complex in the quenched melt.

32277 **Nanosecond resolution time-resolved x-ray study of silicon during pulsed-laser irradiation.** Larson, B.C.; Tischler, J.Z.; Mills, D.M. (Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Materials Research;* 1: No. 1, 144-154(Jan 1986). Contract AC05-84OR21400.

We have used the pulsed time structure of the Cornell High-Energy Synchrotron Source (CHESS) to carry out a nanosecond resolution time-resolved x-ray study of silicon during pulsed-laser irradiation. Time-resolved temperature distributions and interfacial overheating and undercooling were measured on <111> and <100> silicon during 25 ns UV laser pulses through the analysis of thermal expansion induced strain. The temperature gradients were found to be $>10^7$ K/cm at the liquid—solid interface and the temperature distributions have been shown to be in agreement with numerical heat flow calculations for these laser conditions. The combined overheating and undercooling (during ~10 m/s melting and ~6 m/s regrowth) was measured to be 110 +- 30 K on <111> oriented silicon and 50 +- 25 K on <100> silicon. These values have been interpreted in terms of velocity coefficients of overheating and undercooling.

32278 **High-resolution transmission electron microscopy on KH/sub x/—GIC's.** Salamanca-Riba, L.; Yeh, N.; Dresselhaus, M.S.; Endo, M.; Enoki, T. (Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Journal of Materials Research;* 1: No. 1, 177-186(Jan 1986). Contract AC02-83ER45041.

The in-plane and c-axis structure of KH/sub x/—GIC's and KD/sub y/—GIC's is studied using transmission electron microscopy (TEM) and x-ray diffraction as a function of intercalation temperature and time. With the TEM, two commensurate in-plane phases are found to coexist in these compounds with relative concentrations depending on intercalation conditions. When the direct intercalation method is used, the first step of intercalation is the formation of a stage n potassium—GIC and the final compound is a stage n KH/sub x/—GIC (or KD/sub y/—GIC). High-resolution (00l) lattice images show direct evidence for intermediate phases in the intercalation process. These intermediate phases are hydrogen (deuterium) deficient and are found at the boundary between pure potassium regions and regions with high hydrogen (deuterium) content. A comparison of the structure for the two methods of intercalation of KH is also presented.

32279 **Elastic strain energy and forces on point defects in a two-phase medium.** Jagannadham, K.; Narayan, J. (Materials Engineering Department, North Carolina State University, Raleigh, North Carolina 27650). *Journal of Materials Research;* 1: No. 1, 193-201(Jan 1986). Contract AC05-84OR21400.

Elastic strain energy and forces on point defects in a two-phase medium with a planar interface are analyzed employing the surface dislocation analysis developed earlier for three-dimensional distortions. The important field components, namely, the tractions and the displacements arising due to the point source at the interface, are determined. Furthermore, the field components at the interface are used to determine the elastic strain energy associated with the point source in the two-phase medium and the elastic force exerted by the second phase on the point defect. The significance of these results to the force acting on a vacancy or an interstitial at the interface is emphasized.

32280 **Ion beam processing of $LiNbO_3$.** Appleton, B.R.; Beardsley, G.M.; Farlow, G.C.; Christie, W.H.; Ashley, P.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Materials Research;* 1: No. 1, 104-113(Jan 1986). Contract AC05-84OR21400.

Ion implantation and ion beam mixing have been investigated as alternative techniques to high-temperature diffusion for introducing dopants into $LiNbO_3$. Heavy ion bombardment at both 77 and 300 K initiated a near-surface decomposition causing Li to diffuse to the surface where it formed a nonuniform agglomerate. The damage and annealing characteristics of this effect were studied by ion scattering/channeling, secondary ion mass spectrometry, and optical microscopy. The origins of the surface decomposition are discussed along with possible solutions, and selected samples were evaluated for waveguide properties.

32281 **Defect identification in high-purity semiconductors.** Haller, E.E. (Univ. of California, Berkeley). *Materials Research Society Symposia Proceedings;* 46: 495-506(1985). Contract AC03-76SF00098.

The elemental semiconductors silicon and germanium can be purified to electrically active impurity concentrations as low as ~$10^{10}cm^{-3}$. Highly sensitive, energy dispersive analytical techniques have been developed to identify and measure the concentration of the residual elemental impurities. The application of these techniques to very pure materials has also resulted in the discovery of a large number of new levels which are due to impurity/defect complexes. Photothermal ionization spectroscopy using uniaxial stress or a magnetic field, electron paramagnetic resonance, and doping experiments using stable and radioactive elements have been used in combination to identify the composition and the structure of some of the new centers. 36 references, 8 figures, 1 table.

32282 Low density inorganic foams fabricated using microwaves. Meek, T.T.; Blake, R.D.; Gregory, T.G. (Los Alamos National Lab., Materials Science and Technology Div., Los Alamos, NM 87545). pp 1161-1170 of Proceedings of the ninth annual conference on composites and advanced ceramic materials. Columbus, OH; American Ceramic Society, Inc. (1985). (CONF-850122—).

From 9. annual conference on composites and advanced ceramic materials and workshop on testing methods for ceramic matrix composites; Cocoa Beach, FL, USA (20 Jan 1985).

The objective of this work was to determine if high temperature foams could be made using microwave heating and if so, to investigate some of their properties. Several foams were made and their compressive strengths, tensile strengths, and densities were determined. Foams were made of glass, metal-glass, glass-fiber, metal-glass-fiber, and fly ash. The microwave source operated at 2.45 GHz and had an output of 700 W.

32283 Modelling of waste form performance and system release. Barkatt, A.; Macedo, P.B.; Gibson, B.C.; Montrose, C.J. (The Catholic Univ. of America, Washington, DC). pp 3-13 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Kinetic and thermodynamic approaches to the derivation of long-term release rates of species from defense waste glass reviewed. It is concluded that at high flow rates kinetic factors are pre-dominant, while at low flow rates saturation of the aqueous medium with respect to major matrix elements, particularly with respect to silica present in the glass and in its alteration products, become a controlling factor. Quantitative calculations indicate that under likely repository conditions the release rates can be expected, in general, to fall below the NRC criterion of 10^{-5} yr-1. 30 refs., 6 figs.

32284 Control of oxidation potential for basalt repository simulation tests. Jantzen, C.M.; Wicks, G.G. (E.I. du Pont de Mours and Co., Aiken, SC). pp 29-35 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Borosilicate waste glass durability in simulated repository environments can be assessed by use of static tests in leach vessels fabricated of the representative geomedia. Control of the oxidation potential during the test simulates a basalt repository environment. Under very anoxic conditions (i.e. at negative Eh values), the interactions between basalt and SRP waste glass in silica-saturated basaltic groundwaters are the same as those of basalt and groundwater when no waste glass is present. The lack of significant leaching of ions from the waste glass and the lack of any significant changes in either the leached surfaces of glass or basalt under anoxic conditions suggests that the components of this system are at equilibrium when oxygen is absent. 11 refs., 4 figs.

32285 Effects of flow parameters on the leaching of nuclear waste glass. Adiga, R.B.; Akomer, E.P.; Clark, D.E. (Univ. of Florida, Gainesville). pp 45-54 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Environmental conditions in a repository are expected to be significantly different from those encountered by a glass tested under MCC-1 specifications. In addition to variations in flow rate and glass surface area to water volume ratio (SA/V), the water chemistry and presence of waste package components in the repository will most certainly affect the leaching behavior of the glass. Few, if any, investigations have been conducted in which the combined effects of these variables have been studied. Thus, our major goal was to evaluate the changes in leaching behavior resulting from various combinations of flow rate, SA/V, water chemistry and waste package components. It is not possible to define with exactitude the environmental conditions to which the waste glass will be exposed because waste package and repository design are still evolving. However, there have been sufficient studies to demonstrate clearly that any groundwater that contacts the defense waste glass will be well below 100°C. Thus all of the tests reported in the investigation are at 90°C. Because of the large number of potential repository materials and water chemistries, it was necessary to limit our investigation to ductile iron and a synthetic silicate groundwater.

32286 Characterization of hydrated surface layers on nuclear waste glasses in infrared reflectance spectroscopy. Zellmer, L.A.; White, W.B. (Pennsylvania State Univ., University Park). pp 73-80 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The reaction between aqueous solutions and borosilicate glasses designed for commercial or defense waste immobilization produces a hydrated layer on the surface of the glass which can be characterized by infrared reflectance spectroscopy. Specular reflectance curves, obtained by Fourier transforms infrared spectroscopy, can be deconvoluted by Kramers-Kronig analysis to obtain true absorption spectra. The pattern of Si-O stretching modes changes for alkali silicate glass, indicating changes in the network polymerization. The characterization intense band of the borosilicate glasses simply changes intensity in a way that scales with degree of hydration. The progressive hydration of the glass surface also appears as a broad OH band which can be extracted from the reflectance curve by the deconvolution process. 11 refs., 5 figs.

32287 Determination of early stages of glass dissolution by pH titration. Garland, J.A.; White, W.B. (Pennsylvania State Univ., University Park). pp 81-88 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The early stages of glass dissolution are marked by rapid changes in pH for leach solutions with low buffer capacity. Consideration of both dissolution reactions and the electrical neutrality requirement allow the calculation of exchanged cation equivalents from the depletion of the H^+-ion reservoir. Comparison was made between sodium trisilicate glass, a commercial waste glass (PNL 76-68), and the defense waste reference glass. The released Na^+ calculated from the pH curve of sodium trisilicate glass has the expected parabolic dependence on time. The nuclear waste glasses react with H^+ more slowly and the pH - time plots do not have the shape of a titration curve. The equivalents of cations released follow a power law function, the exponent of which depends on initial pH. There are two distinct rate regimes for all glasses with initial fast rates related to consumption of H^+ and later, slower rates nearly independent of H^+ activity. 9 refs., 7 figs.

32288 Nuclear reaction analysis technique to determine the penetration of hydrogenic species into glasses exposed to leaching solutions. Gignac, L.M.; Altstetter, C.J.; Brown, S.D. (Univ. of Illinois, Urbana). pp 107-112 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Nuclear reaction analysis is discussed as a method for determining the distribution of deuterium beneath the surfaces of glasses exposed to heavy water solutions for various times and temperatures. Limited examples of both conventional depth profiling for deuterium and a new technique for deuterium mapping are presented. The possible use of deuterium mapping for investigating the ki-

netics and mechanisms of the leaching of glasses is discussed. 14 refs., 2 figs., 2 tabs.

32289 **Role of boron in monitoring the leaching of borosilicate glass waste forms.** Sceheetz, B.E.; Freeborn, W.P.; Smith, D.K.; Anderson, C.; Zolensky, M.; White, W.B. (Pennsylvania State Univ., University Park). pp 129-134 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

In the absence of any identified solid phase host (other than the original glass), boron has been assumed to accumulate in the fluid during the reaction of borosilicate glass waste forms with aqueous fluids. Using this assumtion, it is possible to define a boron index which can be used to monitor the amount of glass that has been dissolved and to provide a worst-case measure of the degradation of the primary glass waste forms. Several boron-containing silicate phases have been identified this invalidating the assumption that boron does not precipitate. The effect is apparently small and the assumption that boron release is a direct measure of degree of alteration of borosilicate glass is still probably a good one. 13 refs., 4 figs., 1 tab.

32290 **Leaching of devitrified glass containing simulated SRP nuclear waste.** Jantzen, C.M.; Bickford, D.F. (E.I. du Ponte de Nemours and Co., Aiken, SC). pp 135-146 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Time-temperature-transformation curves have been determined for SRL-165 and SRL-131 waste glasses for all potential waste compositions. SRL-165 glasses, which contains less alkali, exhibit less complex devitrification and higher overall durability than SRL-131 waste glasses. Devitrification was found to have less effect on the durability of waste glasses than changes in composition. Non-uniform dissolution at the glass leached layer interface is observed. However, leached layers formed after 28 days shield the crystal interfaces from further dissolution. 15 refs., 5 figs., 4 tabs.

32291 **Effect of groundwater flow on release rate behavior of borosilicate glass.** Apted, M.J.; Adiga, R. (Pacific Northwest Lab., Richland, WA). pp 163-170 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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A simple open-system model is used to evaluate the effect of groundwater flow on borosilicate glass dissolution. With appropriate assumptions, the mass balance equation is: dc/dt = R - k/sub f/ c; R = k(c/sub eq/ - c) where c is the concentration of dissolved species i, t is time, k/sub f/ is the flushing frequency (i.e., volumetric flow rate divided by fixed pore volume), and R is the normalized rate of dissolution. A first-order dependence of R on departure of c from the equilibrium saturation concentration, c/sub eq/, is also assumed. Results from steady-state (dc/dt = O; c = c/sub ss/ = constant) static and dynamic flow tests on a borosilicate glass at 90°C were used to calculate R and the dissolution rate constant, k, as a function of flow rate. The calculated results of the model are in good agreement with independent measurements. There are three important conclusion. First, even the slowest flow rate used (0.1 mlh) corresponds to a high flow rate with respect to the intrinsic dissolution rate of the glass and expected repository flow conditions. Second, previous release models that scale radionuclide release rate directly to solubility concentration may overestimate release at high flow rates. This is because previous models fail to account for the pronounced decrease in steady-state solution concentration at the solid interface with increasing flow rate. Third, increased flow rate accelerates the glass dissolution rate without changing the reaction mechanism. This effect is attributable to constant replenishment of undersaturated solution at the glass surface and an apparent increase in the dissolution rate constant with increasing flow rate. 21 refs., 1 fig., 1 tab.

32292 **International Waste Glass Study. Composition and leachbility correlations.** Wicks, G.G.; Rankin, W.D.; Gore, S.L. (E. I. du Pont de Nemours and Co., Aiken, SC). pp 171-177 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

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The International Waste Glass Study found important similarities, based on correlations of composition and leaching performance, among many different defense and commercial waste glass compositions being studied world-wide. In addition, the beneficial effect of waste on glass performance was confirmed for the systems evaluated. 6 refs., 2 figs., 4 tabs.

32293 **Effect of various lead species on the leaching behavior of borosilicate waste glass.** Lehman, R.L.; Kuchinski, F.A. (Rutgers-the State Univ., Picataway, NJ). pp 179-186 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

A borosilicate nuclear waste glass was static leached in pure water, silicate water, and brine solution. Three different forms of lead were included in specified corrosion cells to assess the extent to which various lead species alter the leaching behavior of the glass. Weight loss data indicated that Pb/sub m/ amd PbO greatly reduce the weight loss of glass when leached in pure water, and similar effects were noted in silicate and brine. Si concentrations, which were substantial in the glass-alone leachate, were reduced to below detection limits in all pure water cells containing a lead form. Lead concentration levels in the leachate were controlled by lead form solubility and appeared to be a significant factor in influencing apparent leaching behavior. Surface analysis revealed surface crystals, which probably formed when soluble lead in the leachate reacted with dissolved or activated silica at the glass surface. The net effect was to reduce the lease of some glass constituents to the leachate, although it was not clear whether the actual corrosion of the glass surface was reduced. Significantly different corrosion inhibiting effects were noted among lead metal and two forms of lead oxide. 9 refs., 7 figs., 3 tabs.

32294 **One-year leaching of three SRL glasses in granite.** Zhu, B.F.; Clark, D.E.; Hench, L.L.; Wicks, G.G.; Werme, L. (Univ. of Florida, Gainesville; E.I. du Pont de Nemours and Co., Aiken, SC; Swedish Nuclear Fuel Supply Co., Stockholm). pp 187-194 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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Three Savannah River Laboratory (SRL) simulated nuclear waste glasses were buried in granite boreholes 345 meters deep. Included in the same boreholes were other potential waste package components including stainless steel and bentonite. Samples were maintained at either ambient mine temperature (8 to 10°C) or 90°C. Differences in the leaching performances were observed among the three compositions, with SRL 165 being more durable than SRL 131, both with 29.8% TDS waste. Likewise, the presence of some package components affected the leaching performances. Bentonite resulted in accelerated attack on the glass while the presence of stainless steel did not appear to have much affect. Results obtained through one year of burial are presented. 6 refs., 5 figs., 2 tabs.

32295 **Early stages of film formation during the leaching of radioactive waste glasses.** Houser, C.A.; Pantano, C.G. (Pennsylvania State Univ., University Park). pp 205-212 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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The early stages of surface alteration-layer formation were examined during the leaching of some candidate radioactive waste glasses. The composition-depth profiles of the leached surfaces were obtained with sputter-induced photon spectroscopy (SIPS) and secondary-ion mass spectroscopy (SIMS). It was observed that the formation of multiple surface layers is a general feature of the glass dissolution process. The sequence of the layer compositions depends upon the order in which solubility limits are attained in solution, the adsorption or precipitation of insoluble hydrates at the glass/water interface, and subsequent incorporation of these insoluble hydrates at the glass/water interface, and subsequent incorporation of these insoluble hydrates behind the advancing reaction front. The boundary between the surface layer and bulk glass is sharp. 8 refs., 5 figs.

32296 **Electrokinetics, adsorption and colloid study of simulated nuclear waste glasses leached in aqueous solutions.** Lee, C.T.; Clark, D.E. (Univ. of Florida, Gainesville). pp 221-228 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Zeta potentials of SRL-131-29.8% TDS simulated nuclear waste glasses leached in D.I. water, Al, Ca, Mg, and Zn chloride solutions at 90°C were measured as a function of leaching time. For short-term leaching, the adsorption of Ca, Mg, Zn, and Al reverses the glass surface potential from negative to positive. Colloids were found to be stable in D.I. water and $AlCl_3$ solutions after leaching, presumably due to the electrostatic repulsion between the glass surface and similarly charged particles. Colloids were not found in Mg, Zn, or Ca chloride solutions after leaching; instead, a relatively thick metasilicate surface layer was formed on glass surfaces leached in these solutions. The concentration of Si in solution is reduced by the formation of these surface layers. 7 refs., 3 figs., 1 tab.

32297 **Kinetic model of nuclear waste glass dissolution in flowing water environments.** Barkatt, A.; Gibson, B.C.; Brandys, M. (Hebrew Univ., Jerusalem, Israel). pp 229-236 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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A simple kinetic model for the description of the interaction of nuclear waste borosilicate glass with water has been developed. In the case of SRL TDS-131 glass leached in water at 70°C over a broad range of flow rated theis model was found useful both in describing the evolution of leachate composition as a function of exposure time at a particular flow rate and in describing the dependence of the steady-state concentrations of the leached elements in solution on flow rate in a series of flow experiments. 18 refs., 3 figs.

32298 **Leaching Savahhanh River Plant nuclear waste glass in a saturated tuff environment.** Bibler, N.E.; Wicks, G.G.; Oversby, V.M. (E.I. du Pont de Nemours and Co., Aiken, SC; Lawrence Livermore National Lab., CA). pp 247-256 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Samples of SRP glass containing either simulated or actual radioactive waste were leached at 90°C under conditions simulating a saturated tuff repository environment. The leach vessels were fabricated of tuff and actual tuff groundwater was used. Thus, the glass was leached only in the presence of those materials (including the Type 304L stainless steel canister material) that would be in the actual repository. Tests were performed for time periods up to 6 months at a SA/V ratio of 100 m^{-1}. Results with glass containing simulated waste indicated that stainless steel canister material around the glass did not significantly affect the leaching. Based on Li and B (elements not in significant concentrations in the tuff or tuff groundwater), glass containing simulated waste leached identically to glass containing actual radioactive waste. The tuff buffered the pH so that only a slight increase was observed as a result of leaching. Results with glass containing actual radioactive waste indicated that tuff reduced the concentrations of Cs-137, Sr-90, and Pu-238 in the free ground water in the simulated repository by 10 to 100X. Also, radiolysis of the groundwater by the glass (approximately 100 rad/hr) did not significantly affect the ph in the presence of tuff. Measured normalized mass losses in the presence of tuff for the glass based on Cs-137, Sr-90, and Pu-238 in the free groundwater were extremely low, nominally 0.02, 0.02, and 0.005 g/m^2, respectively, indicating that the glass-tuff system retained radionuclides well. 9 refs., 2 figs., 3 tabs.

32299 **Behavior of actinide containing glassed during gamma irradiation in a saturated tuff environment.** Bates, J.K.; Oversby, V.M. (Argonne National Lab., IL; Lawrence Livermore National Lab., CA). pp 257-264 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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The influence of gamma irradiation on the reaction of actinide doped SRL 165 and PNL 76-68 glasses in a saturated tuff environment has been studied in a series of tests lasting up to 56 days. The reaction, and subsequent actinide release, of both glasses depend on the dynamic interaction between radiolysis effects which cause the solution pH to become more acidic and glass reaction which drives the pH more basic. The use of large gamma irradiation dose rates to accelerate reactions that would occur in an actual repository radiation field may affect this dynamic balance by unduly influencing the mechanism of the glass-water reaction. Comparisons are made between the present results and data obtained by reacting the same or similar glasses using MCC-1 and NNWSI rock cup procedures. 11 refs., 3 figs.

32300 **Parametric testing of a DWPF borosilicate glass.** Bazan, F.; Rego, J. (Lawrence Livermore National Laboratory, CA). pp 303-310 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract W-7405-ENG-48.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

A series of tests have been performed to characterize the chemical stability of a DWPF borosilicate glass sample as part of the Waste Package Task of the NNWSI Project. This material was prepared at the Savannah River Laboratory for the purpose of testing the 165-frit matrix doped with a simulated non-radioactive waste. All tests were conducted at 90°C using deionized water and J-13 water (a tuffaceous formation groundwater). In the deionized water tests, both monoliths and crushed glass were tested at various ratios of surface area of the sample to volume of water in order to compare leach rates for different sample geometries or leaching times. Effects on the leach rates due to the presence of crushed tuff and stainless steel material were also investigated in the tests with J-13 water. 4 refs., 2 figs., 4 tabs.

32301 **Mass transfer in a geologic environment.** Zavoshy, S.J.; Chambre, P.L.; Pigford, T.H. (Univ. of California, Berkeley). pp 311-322 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC03-76SF00098.

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A new analytical solution is presented that predicts the rate of dissolution of species from a waste package surrounded by a wet porous medium. By equating the rate of diffusive mass transfer into the porous rock to the rate of liquid-surface chemical reaction, and analytical solution for the time-dependent dissolution rate and the time-dependent concentration of dissolved species at the waste surface is obtained. From these results it is shown that for most of the important species in a package of radioactive waste the surface

liquid quickly reaches near-saturation concentrations and the dissolution rate can be predicted by the simpler theory that assumes saturation concentrations in the surfaces liquid. 26 refs., 3 figs., 1 tab.

32302 **^{237}Np and ^{239}Pu solution behavior during hydrothermal testing of simulated nuclear waste glass with basalt and steel.** Schramke, J.A.; Simonson, S.A.; Coles, D.G. (Pacific Northwest Laboratory, Richland, WA). pp 343-350 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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A series of hydrothermal experiments were carried out on ^{237}Np- and ^{239}Pu-doped PNL 76-68 glass, synthetic basalt groundwater, basalt, and cast steel. These hydrothermal experiments are part of the Basalt Waste Isolation Project investigation of the interactions of waste package components in a basalt repository. Experiments of three months duration were conducted in Dickson-type rocking autoclaves at 200°C amd 30 MPa, with an initial fluid to solid weight ratio of 10:1. All solid materials were ground and sieved to a narrow size fraction. The experiments carried out were: glass and groundwater; glass, basalt, and groundwater; glass, steel, and groundwater; and glass, steel basalt, and groundwater. Unfiltered, 4000 A filtered, and 18 A filtered solutions were analyzed to determine the concentrations of radionuclides in solution and those associated with colloids. The quantities of ^{237}Np and ^{239}Pu in solution were very small. Worstcase calculations indicate that 0.01% or less of the total radionuclide inventories were present in solution. The highest solution concentrations of the actinide dopants were observed in the experiments with basalt, even though smaller amounts of glass were dissolved than in the experiments without basalt. The observed differences in the solution concentrations of ^{237}Np and ^{239}Pu were probably controlled by differences in the reaction products, which were clinoptilolite in the experiments with basalt, and an Fe-Zn smectite clay in the experiments without basalt. 7 refs., 6 figs.

32303 **Hydrothermal studies of simulated defense waste glass plus basalt.** Allen, C.C.; Lane, D.L.; Johnston, R.G.; Marcy, A.D.; Adee, R.R. (Rockwell Hanford Operations, Richland, WA; Pacific Northwest Lab., Richland, WA). pp 451-458 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-77RL01030.

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The Basalt Waste isolation Project (BWIP) is conducted for the US Department of Energy (DOE) by Rockwell Hanford Operations (Rockwell). The BWIP has undertaken an experimental program to test the behavior of defense waste glass under conditions relevant to a repository in basalt. Three autoclave experiments utilizing a nonradioactive simulated waste glass (Savannah River Laboratory (SRL) Type 131/TDS-3A) have been completed. Monolithic discs and crushed glass particles were reacted with crushed basalt and synthetic basalt groundwater for ~1 yr at temperatures of 90°C to 150°C. The crushed glass proved considerably more reactive than the monoliths at similar temperatures. Raising the temperature from 90°C to 150°C produced a striking increase in the extent of glass alteration. At 150°C, essentially all of the boron and most of the sodium in the glass particles were released. The major reaction products in all three experiments were smectite clay and zeolites. The two tests utilizing crushed glass also yielded analcime. Nickel, cesium, and strontium, important elements in defense waste, were released from the glass in small quantities. The nickel was incorporated into the clay, while the cesium was incorporated into the analcime. 19 refs., 2 figs., 2 tabs.

32304 **Hydrothermal waste package interactions with methane-containing basalt groundwater.** McGrail, B.P. (Pacific Northwest Lab., Richland, WA). pp 459-466 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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Hydrothermal waste package interaction tests were conducted with a mixture of crushed glass, basalt, and steel in methane-containing synthetic basalt groundwater. In the absence of gamma radiolysis, methane was found to have little influence on the corrosion behavior of the waste package constituents. Under gamma radiolysis, methane was found to significantly lower the solution oxidation potential when compared to identical tests without methane. In addition, colloidal hydrocarbon polymers that have been produced under the irradiation conditions of these experiments were not formed. The presence of the waste package constituents apparently inhibited the formation of the polymers. However, the mechanism which prevented their formation was not determined.

32305 **Rapid increases in permeability and porosity of bentonite-sand mixtures due to alteration by water vapor.** Couture, R.A. (Argonne National Lab., IL). pp 515-522 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Packed columns of canister packing material containing 25% bentonite and 75% quartz or basalt sand, were exposed to water vapor at temperatures up to 260°C. The permeabilities of the columns were subsequently measured after complete saturation with liquid water in a pressurized system. Exposure to water vapor caused irreversible increases in permeability by factors of up to 10^5. After saturation with liquid water, the permeability was nearly independent of temperature. The increases in permeability were due to a large decrease in the ability of the bentonite to swell in water. Calculations suggest that swelling of bentonite exposed to water vapor at 250°C was not sufficient to fill the pore spaces. If the pore spaces are filled, the mixture will form an effective barrier against flow, diffusion, and transport of colloids. The results suggest that if bentonite-based canister packing material is exposed even briefly to water vapor at high temperatures in a high-level nuclear waste repoistory, its performance will be seriously imparied. The problem will be less severe if the proportion of bentonite is high and the material is highly compacted. Previous results show significant degradation of bentonite by water vapor at temperatures as low as 150°C. This suggests that in some repositories, backfill in tunnels and drifts may also be affected. 9 refs., 5 figs., 1 tab.

32306 **Swelling pressures of compacted bentonite/sand mixtures.** Gray, M.N.; Cheung, S.C.H.; Dixon, D.A. (Atomic Energy of Canada Ltd., Manitoba, Canada). pp 523-530 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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Compacted bentonitic clay/sand mixtures are being considered for use as buffer materials in the Canadian concept for nuclear fuel waste disposal. This paper describes a laboratory study of the swelling pressures that develop in statically compacted, air-dry specimens of mixtures of sodium bentonite and silica sand as they are saturated with double-distilled, deionized water. The results are interpreted with the aid of scanning electron microscope observations of the soils' structures. It is shown that the sand acts as an inert filler material, and swelling pressures are controlled by a parameter termed the effective clay dry density, γ/sub c/, defined as the ratio of the mass of clay to the combined volume of the clay plus voids in the mixture. A threshold value of γ/sub c/ exists below which swelling pressures can be expected to be isotropic. Above the threshold value of γ/sub c/, pressures parallel to the axis of compaction can be expected to be greater than those perpendicular to it. This is related to a change in soil fabric as γ/sub c/ is increased above the threshold value. For the Canadian disposal concept, γ/sub c/ would probably be below the limiting value and swelling pressures of 2.5 MPd or less are expected. The swelling pressures are likely to be isotropic within a saturated buffer mass. 13 refs., 4 figs.

32307 Nonlinear concentration effects on radionuclide diffusion and mobility in compacted bentonite. Anderson, H.M.; Chiao, F.S. (Univ. of New Mexico, Albuquerque, NM). pp 531-538 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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This paper examines some previously reported experimental results on the migration behavior of selected radionuclides in compacted bentonite and demonstrates that a much better agreement between observed and theoretically predicted migration behavior can be obtained when the model considers nonlinear concentration effects. The radionuclide transport model used in this study employs a semi-analytic, integral equation approach to the solution of the diffusion equation with nonlinear retardation mechanisms. The effect of radionuclide concentration on species mobility is modeled as a highly nonlinear Freundlich isotherm. Several empirical correlations using the Freundlich isotherm form for retardation are presented and are shown to account for the deviation from linearity in the diffusion model for migration behavior. These correlations are then used in further numerical studies of long term backfill barrier perfomance for 3 and 4 member chain species after a hypothetical canister failure. The overall importance of nonlinear concentration effects to radionuclide migration estimation is discussed. 10 refs., 8 figs., 1 tab.

32308 Baslat glass: an analogue for the ecaluation of the long-term stability of nuclear waste form borosilicate glasses. Byers, C.D.; Jercinovic, M.J.; Ewing, R.C.; Keil, K. (Argonne National Lab., IL; Univ. of New Mexico, Albuquerque). pp 583-590 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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The long-term stability of nuclear waste form borosilicate glasses can be evaluated by understanding the processes that effect the long-term alteration of glass and by comparing laboratory alteration of synthetic basalt and borosilicate glasses with the observed stability of naturally occurring basaltic glasses in diverse geologic environments. This paper presents detailed electron microprobe analyses of naturally altered basaltic glasses (with maximum ages of 10,000 to 20 million years) from low-temperature environment. These results are compared to laboratory data on the corrosion of a synthetic basaltic glass in MCC-1 tests (90°C, a SA/V of 0.1 cm^{-1} and time periods up to 180 days), MCC-2 tests (190°C, a SA/V of 0.1 cm^{-1} and time periods up to 210 days) and hydration tests in saturated water vapor (240°C, an estimated SA/V of $\sim 10^6$ cm^{-1} and time periods up to 63 days). Additionally, laboratory induced hydration alteration of synthetic basalt and borosilicate glasses is compared. These preliminary experiments provide evidence that the alteration processes observed for natural basalt glasses are relevant to understanding the alteration of nuclear waste glass, as both appear to react via similar processes. 12 refs., 6 figs.

32309 Ion implantation damage processes in nuclear waste glass and other silicate glasses. Arnold, G.W. (Sandia National Labs., Albuquerque, NM). pp 617-622 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC04-76DP00789.

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Cantilever beam measurements of induced lateral stress have been made for He, Xe, and pb ion-implantation into the complex borosilicate radioactive waste glasses (PNL 76-68, SRP), a commercial borosilicate (Pyrex), and into fused SiO_2 (Suprasil 1). For the borosilicate glasses, implantation caused a buildup of stress to a saturation value ($\sim 1 \times 10^8$ dynes/cm). The maximum occurred at ion fluences greater than those found for maximum stress in fused silica and without a stress relief mechanism. The separate family of stress curves for Pyrex and PNL 76-68 coincide when stress is plotted as a function of energy into electronic processes. Pyrex has 13 wgt.% B_2O_3 and 81 wgt.% SiO_2, while PNL 76-68 and SRP have 10% B_2O_3, 40% SiO_2 and 15% B_2O_3 and 58% SiO_2, respectively. Pyrex is known to be phase-separated, and the waste glasses are susceptible to phase separation. It is suggested that the B_2O_3 phase may be more easily compacted than the SiO_2 phase. The evidently greater effectiveness of the ionization component of the ion energy in creating damage in borosilicate glasses should be of considerable interest in waste glass studies because of the large amounts of ionization from α-decay ($\sim$5 MeV He).

32310 Gamma and alpha radiolysis of salt brines. Gray, W.J.; Simonson, S.A. (Pacific Northwest Lab., Richland, WA). pp 623-630 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

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Gamma radiolysis of Permian Basin brine leads to equilibrium gas pressure of about 100 atm. at 75°C, providing the gas space is very small and/or the total dose is very high. Dose rate dependence is being investigated but is not yet established. Alpha radiolysis of Permian Basin brine is still being evaluated, but it is clear that equilibrium gas pressures will be much higher than with gamma radiolysis. In addition, alpha radiolysis of brine results in a very high solution redox potential. Gas compositions in all cases have been about two parts H_2 to one part O_2. Effort to simulate these results with computer models have been quite successful. 8 refs., 6 figs.

32311 Crystal chemical constraints on the formation of actinide pyrochlores. Chakoumakos, B.C.; Ewing, R.C. (Univ. of New Mexico, Albuquerque). pp 641-646 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract FG04-84ER45099.

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The pyrochlore structure type, A/sub 1-2/B_2O_6Y/sub 0-1/ Fd3m Z=8, is a common constituent of polyphase, crystalline waste forms. Naturally occurring minerals with the same structure often occur in the radiation damaged, electron-diffraction amorphous, "metamict" state; and therefore, a principal concern with phases of this structure type is the effect of alpha-recoil damage associated with the presence of actinides. In this paper we outline crystal chemical constraints on the formation of novel actinide pyrochlores. 24 refs., 1 fig., 2 tabs.

32312 Natural pyrochlores: analogues for actinide host phases in radioactive waste forms. Lumpkin, G.R.; Ewing, R.C. (Univ. of New Mexico, Albuquerque). pp 647-654 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract FG04-84ER45099.

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Significant amounts of the pyrochlore structure type, and derivative structures like zirconolite, have been reported to occur in crystalline, polyphase, nuclear waste forms. Pyrochlore has abundant and chemically diverse natural analogues. Many of these contain U and Th and have been transformed to the electron-diffraction amorphous, "metamict" state by alpha-recoil nuclei. A variety of geochemical alteration processes may occur before, during, and after reaching the final saturation level for alpha-recoil damage ($\sim 10^{26}$ alpha-event/m^3). The purpose of this paper is to examine these alteration effects in radiation-damaged natural pyrochlores. 14 refs., 3 figs., 2 tabs.

32313 **Investigation of metamict and annealed natural pyrochlores by x-ray absorption spectroscopy.** Greegor, R.B.; Lytle, F.W.; Chakoumakos, B.C.; Lumpkin, G.R.; Ewing, R.C. (Univ. of New Mexico, Albuquerque). pp 655-662 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract FG06-84ER45121.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The pyrochlore structure type, A/sub 1-2/B_2O_6Y/sub 0-1/, is a common phase in polycrystalline waste forms. A principal concern has been the effect of alpha-recoil events on the long-term stability of these phases. Naturally occurring minerals of the pyrochlore group provide an example of the full range of radiation effects from fully crystalline to x-ray diffraction amorphous (the metamict state). X-ray absorption spectroscopy is used to investigate the coordination geometry of T-sites in metamict and annealed (1,000°C) pyrochlores. The principal effects in the fully-damaged material ($\sim 10^{26}$ alpha events/m^3) compared to annealed samples include an increase in the asymmetry of the Tr-site and a slight reduction in bond length and coordination number. 23 refs., 3 figs., 1 tab.

32314 **Effects of alpha irradiation on barium hollandite and nickel-iron spinel.** Weber, W.J. (Pacific Northwest Lab., Richland, WA). pp 671-678 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Barium hollandite ($BaAl_2Ti_6O_{16}$) and nickel-iron spinel have been irradiated with alpha particles emitted from a PuO_2 source in order to simulate the effects from alpha particles emitted in adjacent actinide-containing phases of the SYNROC assemblage. The unit cell of barium hollandite undergoes an apparent volume expansion of several percent and a weak transformation from a tetragonal to a monoclinic structure when irradiated with alpha particles to a fluence of 3 x 10^{20} alphas/m^2 ($\sim$ 0.05 dpa). The spinel structure, however, is stable with respect to alpha irradiation and the irradiation-induced volume expansion of the unit cell is less than 0.2%. The results are compared with available neutron-irradiation data, and the differences in observed behavior discussed. 21 refs., 5 figs.

32315 **Materials interactions test method to measure radionuclide release from waste forms under repository-relevant conditions.** Strickert, R.G.; Erikson, R.L.; Shade J.W. (Pacific Northwest Lab., Richland, WA). pp 761-766 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

At the request of the Basalt Waste Isolation Project, the Materials Characterization Center has collected and developed a set of procedures for a waste form compliance test method (MCC-14.4). The purpose of the test is to measure the steady-state concentrations of specified radionuclides in solutions contacting a waste form material. The test method uses a crushed waste form and basalt material suspended in a synthetic basalt groundwater and agitated for up to three months at 150°C under anoxic conditions. Elemental and radioisotopic analyses are made on filtered and unfiltered aliquots of the solution. Replicate experiments are performed and simultaneous tests are conducted with an approved test material (ATM) to help ensure precise and reliable data for the actual waste form material. Various features of the test method, equipment, and test conditions are reviewed. Experimental testing using antinide-doped borosilicate glasses are also discussed. 9 refs., 2 tabs.

32316 **Current technical issues related to near-field materials testing.** Shade, J.W. (Pacific Northwest Lab., Richland, WA). pp 775-781 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Some test parameters have become issues in test development either because they are difficult to measure and control or because the significance of their effect on waste form dissolution and alteration is unknown. Issues identified by the MCC are Eh/pH system effects, SA/V effects, temperature effects on sampling, waste package composition effects, colloid formation and stability, radiolysis, and formation kinetics and stability of secondary reaction products. These issues are addressed by the MCC through literature reviews, workshops, and direct investigation with the objective of recommending methods for resolving them. This paper summarizes their status and attempts to identify needs required for their resolution. 7 refs., 1 fig., 2 tabs.

32317 **Effect of radial temperature gradients on glass fracture in simulated high-level waste canisters.** Farnsworth, R.K.; Chan, M.K.W.; Slate, S.C. (Pacific Northwest Lab., Richland, WA). pp 831-838 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The Pacific Northwest Laboratory performed experiments on canisters of simulated high-level waste (HLW) glass to estimate the effects of radial temperature gradients on the degree of glass fracture in actual HLW canisters. Glass cracking may result in an increased amount of fine glass particles that are of concern in transportation and repository safety analyses. A test matrix was developed to examine the effect of air cooling, water quenching, and internal fins on canister cooling rates, radial temperature gradients, glass cracking levels, and particle size distributions. The data shows the reduction of radial temperature gradients to be important in reducing the amount of waste glass fracture. Cracking profiles show that internal carbon steel fins significantly decrease the degree of fracture. Different cooling rates only affect the amount of particles above a certain size. The amount of particles below that size depends on the interaction between the glass and canister. 4 refs., 5 figs.

32318 **Physical properties of saltstone: a Savannah River Plant waste form.** Langton, C.A. (Savannah River Lab., Aiken, SC). pp 859-864 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

A cement-based waste form, "saltstone," has been designed for disposal of Savannah River Plant low-level radioactive salt waste. Laboratory and field tests indicate that this stabilization process greatly reduces the mobility of all of the waste constituents in the surface and near-surface environment. Bulk properties of this material have been tailored with respect to salt leach rate, permeability, and compressive strength. Microstructure and mineralogy were characterized by SEM and x-ray diffraction analyses. Compressive strength was found to increase as the water to cement ratio decreased. Porosity and mean pore size increased with increasing water to cement ratios. Bulk diffusivities of the various ions dissolved in the pore solutions were also found to increase as water to cement ratios increased. 5 refs., 4 figs., 5 tabs.

32319 **Leaching of saltstone.** Barnes, M.W.; Langton, C.A.; Roy, D.M. (Pennsylvania State Univ., University Park; Savannah river Lab., Aiken, SC). pp 865-873 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC09-76SR00001.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

A modified IAEA leach test was used to evaluate the relative performance of potential saltstone formulations. The effects of sample size and leach rates for specific ions were determined. Leaching mechanisms were determined for NO_3^-, NO_2^-, SO_4^{-2},

Na^+, Ca^{+2}, and Si. NO_2^-, NO_3-, Na^+, and SO_4-^{2} are listed in order of decreasing leach rates. These ions exhibited high initial leach rates which decreased rapidly with time. High initial rates were attributed to surface wash off and diffusion. Within 10 days leach rates stabilized and can be explained by diffusion. Effective diffusivities for nitrite, nitrate, sodium, and sulfate were calculated from the leaching data. They are 6.4 x 10-^{10}, 4.1 x 10-^{10}, 3.2 x 10-^{10}, and 0.9 x 10-^{10} cm^2/sec, respectively. Negative leach rates were measured for Ca^{+2} and Si in some formulations. This was attributed to precipitation of $CaCO_3$ and hydrated calcium silicate phases on the surfaces of the samples. 4 refs., 11 figs., 1 tab.

32320 **Leachability of cement encapsulated West Valley radwaste streams.** Grant, D.C.; Smeltzer, E.E.; Skriba, M.C.; Cwynar, J.C.; Eisenstatt, L.R. (Westinghouse R and D Center, Pittsburgh, PA; West Valley Nuclear Services, NY). pp 875-882 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC07-81NE44139.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Low-level radwaste streams to be generated during the cleanup of the nuclear fuel reprocessing plant at West Valley, New York will require disposal in an environmentally acceptable manner. A study was conducted to determine if presently identified waste streams could be encapsulated in cement to produce a waste form which complies with present NRC guidelines for the disposal of low-level radwaste streams. One waste stability guideline is leachability which was examined in this study. The leach testing was performed in accordance with the ANS 16.1 procedure. This static, deionized water test examined the leach rate of contaminants from radioactively spiked (Cs-137) samples of each waste type. The data obtained from this method were used to generate from diffusion calculations a parameter called a leachability index (L), which is related to the leaching characteristics of the solidified waste. All waste forms exceeded an L value of 6, which is the minimum suggested by the NRC "Branch Technical Position on Waste Form" for the disposal of Class B and Class C radioactive wastes. 5 refs., 3 tabs.

32321 **Leaching of warm-pressed CsZP-cement composite waste forms.** Fajun, W.; Grutzeck, M.W.; Roy, D.M. (Pennsylvania State Univ., University Park). pp 899-902 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Cesium zirconium phosphate [$CsZr_3(PO_4)_3$ or CsZP] has been mixed with various cement matrix materials, warm pressed, cured and leached at different temperatures. Although hydrated portland cement minerals can immobilize most of U, La, and Nd (as proxies for transuranics) they are less effective in immobilizing Cs, Sr or Ba under ordinary conditions. Earlier published work showed favorable immobilization of Cs in CsZP-cement composite waste forms which compared rather favorably with many other waste forms with respect to Cs leachability. By using warm pressing combined with suitable admixtures rates of 28 to 60 day Cs leachability of the composites have been substantially reduced, attaining values of less than 0.20 g/m^2 d. 8 refs., 1 fig., 3 tabs.

32322 **Iodine waste forms: calcium aluminate hydrate analogues.** Brown, D.R.; Grutzeck, M.W. (Pennsylvania State Univ., University Park). pp 911-918 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC02-83ER45013.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Phase relations in the system 3CaO x Al_2O_3-$CaSO_4$-CaI_2-H_2O in equilibrium with excess water were established by means of room temperature bottle hydration of various bulk chemistries in the system. Starting with end members ettringite (3CaO x Al_2O_3 x 3$CaSO_4$ x 32H_2O) and tetracalcium aluminate monosulfate-12-hydrate (3CaO x Al_2O_3 x $CaSO_4$ x 12H_2O), iodine-substituted analogue phases were synthesized which contained increasingly greater percentages of iodine. The iodine-substitued ettringite was found to be unstable whereas the iodine-substituted monosulfate formed readily. SEM, wet chemistry, ir, and x-ray diffraction characterization of the latter phase suggest that its formula is 3CaO x A_3O_3 x $Ca(IO_3)_2$ x 12H_2O. Cement pellets containing this "AFm" iodine-substituted phase were subjected to a modified MCC-1 static leach test. Although the normalized iodine leach rate was relatively high when compared with AgI encapsulated in portland Type III cement, this same leach rate was approximately equal to the rates that have been reported for $Ba(IO_3)_2$, $Ca(IO_3)_2$, and $Hg(IO_3)_2$ in portland cement. The normalized iodine leach rate obtained also was found to be roughly comparable to that given for I-sodalite in cement. Diffusion is indicated as the primary leach mechanism, becoming dominant after the first three days of leaching. 9 refs., 5 figs., 3 tabs.

32323 **Leachability of decontamination reagents from cement waste forms.** Piciulo, P.L.; Davis, M.S.; Adams, J.W. (Brookhaven National Lab., Upton, NY). pp 919-926 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Brookhaven National Laboratory, in order to provide technical information needed by the US Nuclear Regulatory Commission to evaluate the adequacy of near-surface disposal of decontamination wastes, has begun to study the leachability of organic reagents from solidified simulated decontamination wastes. Laboratory scale cement waste forms containing EDTA, picolinic acid or simulated (low oxidation metallic ion) decontamination reagent were leach tested. Samples containing an organic reagent on either mixed bed ion-exchange resins or anion exchange resins were tested. A fixed interval leach procedure was used, as well as the ANS 16.1 standard procedure. The leachability indices measured for the release of the acid from resin/cement composites are: 10.1 for EDTA on mixed bed resins; 9.1 for picolinic acid on mixed bed resins; 9.2 for picolinic acid on anion exchange resins; 8.8 for picolinic acid in forms containing simulated LOMI reagent on mixed bed resins and 8.7 for picolinic acid in forms containing simulated LOMI reagent on anion exchange resins. The leachability indices measured varied with leach time and the data indicate that a simple diffusion model may not be adequate for defining release from these waste forms.

32324 **Geochemical performance evaluation and characterization of a potential cementitious repository sealing material for application in the Topopah Spring tuff NNWSI investigations.** Scheetz, B.E.; Roy, D.M. (Pennsylvania State Univ., University Park). pp 935-942 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Preliminary geochemical evaluations of some portland cement based materials have been made in Nevada Nuclear Waste Storage Investigations (NNWSI), for possible nuclear waste repository sealing applications in welded tuff focused in the Yucca Mountain area. Portland cement based sealing materials have been evaluated in the NNWSI for possible sealing applications in a nuclear waste repository in the Topopah Spring tuff member. Cementitious sealing materials developed for long-term stability should be as nearly as possible in thermodynamic equilibrium with the host rock, or any disequilibrium should not have negative impact upon the integrity of the host rock. A primary step in achieving this equilibrium condition is to minimize the chemical potential between the sealant and the host rock. Two different approaches were evaluated to achieve this compatibility. The one approach utilized indigenous materials for the formulation of the concrete and the other utilized reactive admixtures to adjust the bulk chemical composition of the concrete formulation to approximate the local rock bulk chemistry. Testing of both formulations at conditions that represented the maximum credible temperature and pressure conditions of a repository were completed and show that the use of an indigenous tuff in the formulation without adjusting the matrix chemistry caused al-

terations which might compromise the performance of the concrete. In contrast, the chemically adjusted cementitious formulation exhibited minimal alteration in the J-13 groundwater of the designed test. 3 refs., 2 figs., 4 tabs.

32325 **Cementitious mixtures for sealing access shafts/boreholes through evaporite and clastic rocks in a radioactive-waste repository.** Wakeley, L.D.; Roy, D.M.; Grutzeck, M.W. (Pennsylvania State Univ., University Park). pp 951-958 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC02-83CH10140.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Geochemically compatible cement-based mixtures were designed for sealing a potential geologic repository for high-level radioactive waste in evaporite and related rock strata. The slightly expansive cementitious mixtures were based on Class H cement and Class C fly ash, with silica and calcium sulfate additives, and a low ratio of water to cementitious solids (w/s = 0.32). Both a salt-free and a salt-containing version were used in tests with anhydrite/siltstone and halite. Although it is difficult to achieve strong bonding between anhydrite and cement-based mixtures, tensile bond strengths, interface permeability, and other properties of the composites as a whole indicate achievement of the desired chemical and physical compatibility between these materials. Integrity of bonding and low permeability to water (on the order of 10^{-6} darcy) suggest the likelihood of attaining durable sealing of repository access shafts/boreholes through the use of such chemically tailored cementitious mixtures. Rock samples used in ongoing sealing studies were obtained from various areas throughout the United States. The data in the present paper represent results for rocks obtained from the Palo Duro Basin and as such typify bedded-salt strata. 11 refs., 3 figs., 4 tabs.

32326 **Effects of exchangeable cation composition on the thermal expansion/contraction of clinoptilolite.** Bish, D.L. (Los Alamos National Lab., New Mexico). *Clays and Clay Minerals;* **32**: No. 6, 444-452(1984).

To understand and predict the effects of a thermal pulse induced by a radioactive waste repository on clinoptilolite-bearing rocks, the lattice parameters of 6 natural and 3 cation-exchanged (Ca, K, Na) clinoptilolites were studied as a function of temperature. The samples were examined at room temperature, under vacuum, and at 50°C increments to 300°C using a high-temperature x-ray powder diffractometer. The unit cell of all samples decreased in volume between 20 and 300°C; Na-saturated clinoptilolite underwent the greatest volume decrease (8.4%) and K-saturated clinoptilolite the smallest (1.6%), of the clinoptilolites studied. The volume decrease for the Ca-saturated clinoptilolite was 3.6%. The highest percentage decrease for each sample was along the b axis, generally 80 to 90% of the total volume decrease. The change in the a axis was the smallest and was usually <5%, although 26.5% of the contraction of the Na-exchanged clinoptilolite was along a. The bulk of the volume contraction of many samples occurred on evacuation at room temperature, demonstrating that the observed changes were due to water loss and not to temperature-induced structural changes. Low-angle scattering was significantly reduced upon evacuation for every sample, and the 110 reflection of clinoptilolite at 7.35°2 θ became obvious, whereas it was not in the untreated samples. These data show that the effects of heating on the unit-cell volume of clinoptilolite depend strongly on the exchangeable cation content. Significant reductions in the unit-cell volumes of natural, mixed Na-K-Ca clinoptilolites could take place in rocks in a repository environment, particularly if the clinoptilolites occurred in unsaturated, dehydrated rock. The unit-cell volumes of clinoptilolites in partially saturated rocks at temperatures below 100°C, however, should not decrease significantiy.

40 CHEMISTRY

4001 Analytical And Separations Chemistry

REFER ALSO TO CITATION(S) 31332, 31333, 31395, 31546, 31564, 31611, 32194, 32286, 32288, 32398, 32654, 32826, 32841, 33340

32327 **(CONF-860467—2) Methods of chemical analysis for selected species in marble and limestone surfaces exposed to the acidic outdoor environment.** Jensen, K.J.; Williams, F.L.; Huff, E.A.; Youngdahl, C.A. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010499.

From Peer review of task group G on effects on materials of the National Acid Precipitation Assessment Program; Durham, NC, USA (7 Apr 1986).

There is concern for marble and limestone exposed to the acidic outdoor environment because they are widely used as the exterior structures of buildings and monuments and because the calcium carbonate stones are especially sensitive to acid. Field tests of these building materials under carefully monitored environmental conditions are being conducted to measure damage rates and ultimately to quantify the individual effects of the important damage mechanisms. The development of further quantitative understanding will provide an improved basis for control strategies. The demonstration, verification, and application of a technique to measure selected surface anionic and cationic species are important contributions to this study. These methods of stone surface chemical analysis, developed for and applied in the National Acid Precipitation Assessment Program (NAPAP), are appropriate to monitor selected species of program interest and are sufficient to determine surface sulfate and nitrate reaction products.

32328 **(ENEA-RT/CHI—82-7) Measurement of the plutonium content in low activity waste containers from reprocessing plant.** Cresti, P.; Frazzoli, F.V.; Grossi, G. (ENEA, Casaccia (Italy). Dipartimento Ciclo del Combustibile). Apr 1982. 39p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86901374.

This report deals with an instrumental approach, based on standard gamma spectrometry, specially developed to match the characteristics of contaminated waste drums produced at EUREX plant during the reprocessing campaign of CANDU spent fuel. On the basis of the experimental data, obtained in laboratory, an evaluation of the performances achievable (detection limit, precision, accuracy) is given.

32329 **(GKSS—85/E/55) Electrodialysis membrane stack MS 3070.** Kneifel, K.; Hattenbach, K.; Martens, U. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.)). 1985. 35p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752031.

Design, operation and assembly of the electrodialysis membrane stack are described. The main element is a new sealing frame which, when coupled with a suitable net spacer, yields a good flow distribution in the cells and largely prevents internal and external leakage. Hydrodynamic and electrochemical measurements are used to select suitable spacer materials and to characterize the stack. The experimental parameters which are essential for stack layout are presented. In addition, the desalination properties are illustrated by examples. (orig./PW). With 19 figs., 6 tabs.

32330 **(INIS-mf—10111) Conference on instrumental activation analysis IAA 85. Abstracts of papers.** (Ceskoslovenska Akademie Ved, Prague. Ceskoslovenska Spektroskopicka Spolecnost). May 1985. 35p. (In Czech and Slovak). (CONF-8505256—Absts.). NTIS (US Sales Only), PC A03/MF A01. File Number DE86701997.

From IAA conference on instrumental activation analysis; Klucenice, Czechoslovakia (12 May 1985).

The conference heard 23 papers dealing with the application of activation analysis in environmental control, the preparation of

calibration standards, gamma spectroscopy, data processing and with the control of the purity of radiopharmaceuticals.

32331 **(IPEN-Pub—67) Extraction of zirconium and hafnium thiocyanates by methyl isobutyl ketone - thiocyanic acid from chloride medium.** Nakamura, A.T.O.; Sood, S.P. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 12p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702004.

The extraction behavior of zirconium and hafnium thiocyanates by hexone - HSCN solvent in chloride medium was investigated by studying the following parameters: free acidity and concentrations of thiocyanate, sulphate and metal ions. The results showed that the extraction of the metals increases with increasing thiocyanate ion concentration in the aqueous phase, and increasing thiocyanic acid concentration in the organic phase. However, this increase leads to lower separation factors. Addition of sulphate ion reduces the extraction of both metals and increases the separation factor. An increase in the metals concentrations results in a slight change in their extraction and in the separation factor. However, at high metal concentration the addition of sulphate ion results in instable aqueous phase due to precipitation of basic sulphates.

32332 **(IPEN-Pub—74) Determination of trace impurities in high purity water by emission spectroscopy and flame photometry.** Charbel, M.Y.; Lordello, A.R. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701999.

A spectrochemical method for the determination of trace amounts of Fe, Mg, Mn, Sn, Cr, Bi, Ni, Ca, Na, Zn, Sr, Al, Ba and Cu in high purity water is described. In addition Na, Li and K are measured by flame photometry. The standards used in the spectrochemical method are prepared by evaporation in hot plate of 50 mL standard solution in Teflon becker to dryness, the residue being dissolved with 500 μL hot HCl (1:1). Four hundred μL of this solution is evaporated under infrared lamp on Apiezon treated flat top graphite electrodes. The residue is submitted to a direct current arc excitation. The accuracy is estimated by the spectrochemical method with a direct procedure sample preparation. The relative standard deviation varies from +- 4% to +- 27%. For the elements Na, Li and K standard solutions are concentrated fifty-fold by a simple evaporation procedure and then measured by flame photometry. The standard deviation and accuracy are given.

32333 **(IPEN-Pub—75) Flame photometric determination of Na, K and Li in uranium compounds.** Sabato, S.F.; Lordello, A.R. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 10p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702000.

A flame photometric method for the determination of Na, K and Li in uranium compounds is described. The uranium is separated by solvent extraction from hydrochloric acid medium with tributyl phosphate. Amounts of uranium in order of 20 μg/ml don't cause any interference in the photometric results. The element Na presents a residual concentration due to the contamination of the reagents. The relative standard deviation is about 10% for the three elements. The relative error varies with the concentration of the element and it is between 1 and 24% for Na, between O and 12% for K and between O and 33% for Li.

32334 **(IPEN-Pub—79) Determination of inorganic radioiodine in ^{131}I- Rose Bengal and ^{131}I- bromosulphthalein.** Toledo e Souza, I.T. de; Pereira, N.P.S. de; Silva, C.P.G. da. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702006.

A rapid miniaturized chromatographic system was developed for fast determination of the proportion of inorganic radioactive iodide from radiopharmaceuticals ^{131}I-Rose Bengal and ^{131}I-Bromosulphthalein. Using 33% W/V aqueous solution of ammonium sulphate of pH 7.5 as a solvent, RF values were determined for radiopharmaceuticals, iodide, iodate to RF 0.0, 0.5, 0.9 respectively. The chromatographic quality control procedures are easy to use, rapid and can be incorporated in a routine quality control program.

32335 **(MINTEK-M—103D) Recovery of a concentrate of tin and tungsten from ore mined at Van Roois Vley.** Guest, R.N. (Council for Mineral Technology, Randburg (South Africa)). 29 Mar 1985. 43p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702005.

Concentration tests using gravity separation, flotation, and magnetic separation showed that it is possible for the high-grade ore mined at Van Roois Vley to be upgraded to a concentrate containing 61 percent Sn-Wo_3 at a recovery of about 80 percent, and for the low-grade ore to be upgraded to 53 percent Sn-WO_3 at the same recovery. However, it is suggested that, under normal mining conditions and with large-scale mining equipment, less fines would be produced and this should lead to an increase in grade and recovery. Mineralogical examinations showed that intermediate fractions produced by tabling contained very few locked particles, and that the grade of the final concentrate on a full-scale plant would probably be higher than that obtained with laboratory equipment. Molybdenite could be a valuable byproduct, but flotation tests of gravity concentrates for selective recovery of the mineral gave variable results. Flotation tests for the removal of fluorspar from the final concentrate were unsuccessful.

32336 **(MINTEK-M—205) Determination of lead, zinc, and magnesium in dolomite and its benefication products by use of x-ray-fluorescence spectrometry.** Jacobs, J.J. (Council for Mineral Technology, Randburg (South Africa)). 30 May 1985. 27p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702002.

An investigation was undertaken on the development of fast, simple, and accurate methods of analysis for lead and zinc in tailings and middlings from dolomite, and for lead, zinc, and magnesium in concentrates obtained from dolomite. A pressed-powder technique and X-ray-fluorescence spectrometry (XRFS) were used. Good agreement was found between the XRFS values for lead and zinc in low concentrations and the values obtained by other techniques of analysis when the calibration for the XRFS method was effected by the use of synthetic standards comprising lead and zinc oxides in a dolomite matrix. For high concentrations of the analytes, all the oxides and sulphides of lead and zinc in the samples had to be converted to the sulphate form, and a matrix correction had to be applied to the assigned values of the oxide calibration standards. The lower limits of detection for lead, zinc, and magnesium were 0,004, 0,003, and 0,18 per cent respectively. The recommended methods are detailed in two appendices.

32337 **(NUREG—1156) Accuracy and detection limits for bioassay measurements in radiation protection. Statistical considerations.** Brodsky, A. (Nuclear Regulatory Commission, Washington, DC (USA). Div. of Radiation Programs and Earth Sciences). Apr 1986. 102p. NTIS, PC A06/MF A01 - GPO. File Number TI86901352.

This report provides statistical concepts and formulas for defining minimum detectable amount (MDA), bias and precision of sample analytical measurements of radioactivity for radiobioassay purposes. The defined statistical quantities and accuracy criteria were developed for use in standard performance criteria for radiobioassay, but are also useful in intralaboratory quality assurance programs. This report also includes a literature review and analysis of accuracy needs and accuracy recommendations of national and international scientific organizations for radiation or radioactivity measurements used for radiation protection purposes. Computer programs are also included for calculating the probabilities of passing or failing multiple analytical tests for different acceptable ranges of bias and precision.

32338 **(ORNL/TM—10003) Separation science and technology: an ORNL perspective.** Pruett, D.J. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 95p. NTIS, PC A05/MF A01; GPO Dep. File Number DE86010429.

This report was prepared as a summary of a fourfold effort: (1) to examine schemes for defining and categorizing the field of separation science and technology; (2) to review several of the major categories of separation techniques in order to determine the most recent developments and future research needs; (3) to consider

selected problems and programs that require advances in separation science and technology as a part of their solution; and (4) to propose suggestions for new directions in separation research at Oak Ridge National Laboratory (ORNL).

32339 **(PB—86-158078/XAB) High-pressure distillation of crude $ZrCl_4$. Open File report.** Skaggs, R.L.; Younghans, J.; Rogers, D.T.; Hunter, D.B. (Bureau of Mines, Albany, OR (USA). Albany Research Center). 26 Dec 1985. 42p. (BM-OFR—11-86). NTIS, PC A03/MF A01.

A high-pressure fractionation column for separation of HfC14 and ZrC14 was built to evaluate the claims of a 1976 Japanese patent (76 65,093). A 35.5-in by 3/4-in ID stainless steel 316 column packed with Inconel 600 helices was operated at 40 kg/sq cm (39 atm) pressure with reboiler and overhead condenser temperatures of 471 and 455 C, respectively. The total reflux operation produced ZrC14, with 800 mol ppm HfC14 in the reboiler and with 5.2 mol pct HfC14 in the overhead. A 4.7-in height equivalent to a theoretical plate was determined using a variable separation factor. Although column corrosion partially obscured the redistribution tendencies of impurities, uranium clearly stayed in the reboiler. Of the potential construction metals exposed during distillation, Inconel 625 and Hastelloy C-276 showed the least corrosion.

32340 **(SAND—85-2391C) Neutron induced particle track mapping of elemental distributions.** Bild, R.W. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 9p. (CONF-860445—10). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010465.

From Materials Research Society spring meeting; Palo Alto, CA, USA (15 Apr 1986).

Thermal neutrons are captured by several elements which emit charged particles as reaction products. These particles leave etchable damage tracks in detector materials placed against a sample, creating a map of the distribution and concentration of the target element. The most common applications are for trace U using fission fragment tracks and B using alpha tracks. Li, N and possibly S and O can also be determined. We have applied the technique to B in metals and coatings, Li in Al, N in glass and U in O-ring seals. Detection limits are better than 10^{-11} g/g for U, 10^{-9} g/g for B, 10^{-6} g/g for Li and 0.1 wt % for N. Spatial resolution for mapping is about 25 μm.

32341 **Intercomparison of the Asaro-Perlman and Brookhaven archaeological ceramic analytical standards.** Sijung Yeh; Harbottle, G. (Brookhaven National Lab., Upton, NY, USA). *Journal of Radioanalytical and Nuclear Chemistry;* **97**: No. 2, 279-291(Feb 1986).

Two fundamentally different standardization systems, widely used in the neutron activation analysis of archaeological ceramics and of other materials, were intercompared using procedures of high precision. The results should permit data standardized under either system to be transformed to the opposite system. The two systems are generally known as the 'Asaro-Perlman' standard and the 'BNL Six-Rocks' standard.

32342 **Potentiometric titrations using pencil and graphite sensors.** Selig, W.S. (Lawrence Livermore National Lab., CA). *Journal of Chemical Education;* **61**: No. 1, 80-81(Jan 1984).

The cost of various commercial indicating electrodes ranges from about $40 for pH electrodes to as much as $355 for a potassium ion-selective electrode. This cost can be reduced to less than $1.50, and in some cases to mere pennies by making sensors from graphite rods and pencils for use in potentiometric titrations. The same sensor can be used for many types of these titrations (acid/base, complexiметric, precipitation, and redox). 8 references, 2 tables.

4002 Inorganic And Physical Chemistry

REFER ALSO TO CITATION(S) 31390, 31398, 31650, 32034, 32829

32343 **(AD-A—164030/9/XAB) Equilibrium studies and redox kinetics of the peroxo complex of zirconium(IV) in acidic perchlorate solution.** Thompson, R.C. (Missouri Univ., Columbia (USA). Dept. of Chemistry). 1985. 8p. NTIS, PC A02/MF A01.

The complexation of zirconium (IV) by hydrogen peroxide was studied in aqueous solutions containing M Zr(IV), M H_2O_2, and M $HClO_4$. The peroxozirconium(IV) complex does not exhibit detectable absorption bands in the visible- or ultraviolet-wavelength regions. Therefore, the equilibrium concentrations of uncomplexed Zr^{4+} and H_2O_2 were measured by the use of the indicators 2-thenoyltrifluoroacetone and titanium(IV), respectively. The principal complex formed is a tetrameric species (4:2) containing four Zr(IV) and two peroxide ions. The value of the formation constant is given. The thermodynamic parameters $\Delta H/sub\ f/^0 = 11.2$ kcal/mol and $\Delta S/sub\ f/^0 = 130$ cal/(deg mol) were calculated from the temperature dependence of K4:2 in 1.96 M HClO4. The variation of the formation constant with acidity at an ionic stength of 2.0 M allows the tentative formulation of the peroxozirconium(IV) complex as $Zr_4(O_22(OH)4(8+)$. The results of concentration-jump kinetic experiments were interpreted. Kinetic studies of the oxidation of peroxozirconium(IV) by cerium(IV) and the reduction by sulfur(IV) in 1.96 M HClO4 yielded a common rate expression. According to the authors interpretation, both systems proceed by a rate-determining ring-opening process on peroxozirconium(IV), followed by rapid attack on an exposed pendant $-O_2H$ unit by the external reagent.

32344 **(CBPF-NF—065/85) Spin-probe spin-label studies of sodium dodecyl sulfate micelles.** Bales, B.L.; Linhares, M.P.; Lima, M.daC.A.B. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701996.

The magnetic interactions of paramagnetic ions with nitroxide labels in micelles was determined by using spin-label, spin-probe technique. The results from EPR spectrometer show that the line broadening is dominated by exchange interactions. This result points to a rapid averaging of dieletric environments.

32345 **(CONF-860425—27) Chemical properties of radon.** Stein, L. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 16p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010508.

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

Radon is frequently regarded as a totally inert element. It is, however, a "metalloid" - an element which lies on the diagonal of the Periodic Table between the true metals and nonmetals and which exhibits some of the characteristics of both. It reacts with fluorine, halogen fluorides, dioxygenyl salts, fluoro-nitrogen salts, and halogen fluoride-metal fluoride complexes to form ionic compounds. Several of the solid reagents can be used to collect radon from air but must be protected from moisture, since they hydrolyze readily. Recently, solutions of nonvolatile, cationic radon have been produced in nonaqueous solvents. Ion-exchange studies have shown that the radon can be quantitatively collected on columns packed with either Nafion resins or complex salts. In its ionic state, radon is able to displace H^+, Na^+, K^+, Cs^+, Ca^{2+}, and Ba^{2+} ions from a number of solid materials. 27 refs., 6 figs.

32346 **(UCID—20669) Preparation of OsB_2 by arc-melting.** Curtis, P.G. (Lawrence Livermore National Lab., CA (USA)). 14 Feb 1986. Contract W-7405-ENG-48. 5p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010491.

The purpose of this work was to develop an arc-melting method to form osmium diboride (OsB_2) in powder form. A description of the starting materials, the arc-melter, experiments, and the preparation of the OsB_2 is included.

32347 X-ray absorption near edge structure (XANES) of $PtCl^{2-}$ b in solid and solution environments. Sham, T.K. (Department of Chemistry, Brookhaven National Laboratory, Upton, New York 11973). *Journal of Chemical Physics;* **84**: No. 12, 7054-7055(15 Jun 1986).

The L/sub III,II/ edge x-ray absorption near edge structure (XANES) of the $PtCl^{2-}{}_4$ noiety in two different environments, (1) solid K_2PtCl_4 and (2) K_2PtCl_4 in aqueous solution is reported. (AIP)

32348 Nonstatistical effects and detailed balance in quasi-classical trajectory calculations of the thermal rate coefficient for $O+OH \rightarrow O_2+H$. Miller, J.A. (Combustion Research Facility, Sandia National Laboratories, Livermore, California 94550). *Journal of Chemical Physics;* **84**: No. 11, 6170-6177(1 Jun 1986).

A detailed theoretical investigation of dynamical effects in the thermal rate coefficient for the title reaction is reported. Quasi-classical trajectory (QCT) calculations in both the forward (+1) and reverse (-1) directions are employed in the analysis. The results are compared with each other, with the variational transition state theory (VTST) calculations of Rai and Truhlar, with previous trajectory results for the reverse reaction, and with experiment. It is found that nonstatistical, or non-RRKM, "recrossing" effects play an important role in determining the thermal rate coefficient (the nonstatistical correction is almost a factor of 4 at 2500 K and nearly a factor of 2 even at 200 K). The results from the two trajectory methods satisfy detailed balance at high temperature, but at low temperature (250—300 K) the (-1) trajectories (through the equilibrium constant) predict a rate coefficient for the title reaction that is higher than that predicted by the (+1) method by about a factor of 2. This discrepancy is attributed to the crude handling of quantum effects near threshold in the (-1) trajectory method. The predictions of the (+1) method are in excellent agreement with experiment over the entire temperature range where experimental results are available (250—2500 K). At high temperatures (T>500 K) the VTST results of Rai and Truhlar predict accurately the rate of formation of HO_2 complexes, but at lower temperatures the VTST and trajectory results are in disagreement. The VTST calculations are unable to predict the thermal rate coefficient of the title reaction at any temperature for a combination of reasons.

32349 Unimolecular reactions and phase space bottlenecks. Davis, M.J.; Gray, S.K. (Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Chemical Physics;* **84**: No. 10, 5389-5411(15 May 1986). Contract W-31-109-ENG-38.

We discuss the phase space bottlenecks for the unimolecular decomposition of HeI_2. An intermolecular bottleneck can be defined in phase space which is a "point of no return" or critical configuration for the unimolecular reaction, even though there is no barrier to dissociation for the simple case studied here, HeI_2 restricted to T-shaped geometry (two degrees of freedom). In addition, one can find intramolecular bottlenecks and the combination of the two types of bottlenecks yields theoretical reaction rates which are in excellent agreement with classical numerical simulations. Rates, derived from an approach using only intermolecular bottlenecks or approaches using both intermolecular and intramolecular bottlenecks, are two orders of magnitude better than simple RRKM rates. The paper further demonstrates how the phase space bottlenecks can be employed to discern probabilities of complex formation and discusses the extension of the present work to other types of reactive systems.

32350 Effect of temperature and pressure on excess electron mobility in n-hexane, 2,2,4-trimethylpentane, and tetramethylsilane. Munoz, R.C.; Holroyd, R.A. (Chemistry Department, Brookhaven National Laboratory, Upton, New York 11973). *Journal of Chemical Physics;* **84**: No. 10, 5810-5815(15 May 1986).

Measurements of excess electron mobility are reported for liquid n-hexane, 2,2,4-trimethylpentane, and tetramethylsilane for pressures from 1 to 2500 bar and for temperatures from 18 to 120 °C. For tetramethylsilane, a liquid that exhibits a high electron mobility, the mobility at constant density is proportional to T/sup -0.9/ between 25 and 100 °C. The results are compared with the Basak—Cohen deformation potential theory. For n-hexane, where the mobility is low, Arrhenius behavior is observed. The isochoric activation energy increases with density. The results in this case are consistent with both the two-state and hopping models. In 2,2,4-trimethylpentane the mobility increases with increasing pressure at room temperature and decreases at high temperature. At 2500 bar and at intermediate temperatures (70—80 °C) the mobility is approximately constant.

32351 High-temperature high-resolution NMR study of ^{23}Na, ^{27}Al and ^{29}Si in molten silicates. Stebbins, J.F.; Murdoch, J.B.; Schneider, E.; Carmichael, I.S.E.; Pines, A. (Univ. of California, Berkeley). *Nature (London);* **314**: No. 6008, 250-252(21 Mar 1985). Contract AC03-76SF00098.

Molecular and atomic motions over longer distances, and with much lower frequencies than interatomic vibrations, have a major role in the energetic and dynamic properties of highly structured liquids such as molten aluminosilicates. Rearrangement with increasing temperature of the polymerized anionic network (composed of linked SiO_4^{4-} and AlO_4^{5-} tetrahedra) controls viscosity and influences thermal expansion and configurational heat capacity. Diffusive motion of network modifying cations (such as Na^+) through the structure allows electrical conductivity and probably also affects entropy. In order to study such motion directly and to compare liquid and glass structure, a novel high-temperature high-resolution NMR apparatus has been developed. The first data on ^{23}Na, ^{27}Al, and ^{29}Si in liquids in the system $Na_2O/Al_2O_3/SiO_2$ at temperature to about 1300°C are reported. Observed changes in NMR resonant frequencies (chemical shifts) give information on the effects of composition on local structure. Line shapes and widths, and relaxation time measurements, reveal details of the dynamics and of the transition from liquid to glass. 13 references, 4 figures.

32352 Effects of calcination on adsorption and CO hydrogenation activity/selectivity of potassium-promoted Fe/SiO_2. Bartholomew, C.H.; Rankin, J.L. New York, NY; American Institute of Chemical Engineers (1985). 21p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract AC22-79ET14809.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Effects of calcination pretreatment on the kinetics and energetics of H_2 adsorption were determined by TPD. Pretreatment effects on the CO hydrogenation activity and selectivity properties were determined with a differential reactor. Calcination increases adsorption strength and dramatically changes CO hydrogenation selectivity.

32353 Aqueous inorganic phase equilibria at high temperatures: some experimental, theoretical, and applied aspects. Marshall, W.L. (Oak Ridge National Lab., TN). *Pure and Applied Chemistry;* **57**: No. 2, 283-301(1985). Contract AC05-84OR21400.

Experimental studies generally performed at this laboratory on the solubility of particular salts and oxides in dilute and concentrated aqueous solutions of electrolytes at temperatures up to 400°C are presented and the techniques used are described. Some of this work applies an extended Debye-Hueckel equation as a function of the ionic strength of the solution at the high temperatures. From the variation with temperature of a particular ionization or solubility equilibrium obtained from the studies, thermodynamic functions at infinity dilution of electrolyte are calculated. The studies describe solubility behavior of sulfate salts in exhibiting retrograde solubilities with increasing temperature. But some 2-2 sulfate salts, like magnesium or nickel sulfates, hydrolytically precipitate oxysulfates or hydroxides in nearly neutral solutions at about 200°C. Other sulfate, fluoride, and phosphate salts form two liquid phases at temperatures of 250-400°C at saturated vapor pressures. The solubility behavior of quartz and amorphous silica in salt solutions is reviewed. Some liquid-vapor critical phenomena are also presented. The studies are shown to apply to several fields such as water desalination, power plant steam generator chemistry, geochemistry, and chemical oceanography of deep ocean hot springs. 86 references, 12 figures.

32354 ^{25}Mg ENDOR and triple resonance in liquid solution of the bacteriochlorophyll a cation and anion radicals. Lendzian, F.; Moebius, K.; Plato, M.; Smith, U.H.; Thurnauer, M.C.; Lubitz, W. (Freie Universitaet Berlin, West Germany). *Chemical Physics Letters;* **111**: No. 6, 583-588(16 Nov 1984). Contract W-31-109-ENG-38.

Solution ^{25}Mg electron-nuclear double resonance (ENDOR) and TRIPLE resonance experiments have been performed on the bacteriochlorophyll a (BChl a) anion and cation radicals enriched in ^{25}Mg. The ^{25}Mg isotropic hyperfine coupling constants for BChl a^+ and BChl a^- have been determined. The values are in good agreement with those obtained from recent molecular orbital calculations. 34 references, 4 figures.

32355 Interpretation of equilibrium exchange rates for nonelementary reactions. Willcox, D.; Kung, H.H. (Northwestern Univ., Evanston, IL). *A.I.Ch.E. Journal (New York);* **30**: No. 5, 725-732(Sep 1984). Contract AC02-78ER04987.

In a system that is close to chemical equilibrium, the relaxation of each elementary step toward equilibrium obeys the linear laws of nonequilibrium thermodynamics. For a series reaction in which the concentration of the intermediate species are low or do not change with time, the relaxation can be characterized by one time constant, which can be associated with an overall equilibrium exchange rate for the overall reaction. The relationship between the overall equilibrium exchange rate and the equilibrium exchange rates of the individual steps is analogous to that between the overall conductance and the individual conductances of a network of electrical resistors in series. A numerical example is presented to show the range of validity of this relationship. Finally, a condition for the determinability of exchange rates is presented. Exchange rates are independently determinable if and only if the determinant of the matrix, whose elements are made up of squares of the inner products of the vectors that are made up of the stoichiometric coefficients of the species in the reactions, is non-zero. 11 references, 2 figures.

32356 Efficient stimulated Raman scattering due to absence of second Stokes growth. Carlsten, J.L.; Telle, J.M.; Wenzel, R.G. (Los Alamos National Lab., NM). *Optics Letters;* **9**: No. 8, 353-355(Aug 1984).

Stimulated Raman scattering of a XeCl laser at 308 nm in a high-pressure H_2 cell shows high conversion into first Stokes (S1) because of an unexpected holdoff of the second Stokes (S2) component. Specifically, a photon efficiency of 88% is obtained into S1. Comparison with a plane-wave model indicates that a theory including a spatially nonuniform gain and higher-order mode generation may be necessary to understand the holdoff of the S2 growth. 15 references, 4 figures.

32357 Solubility data for U(VI) hydroxide and Np(IV) hydrous oxide: application of MCC-3 methodology. Krupka, K.M.; Rai, D.; Fulton, R.W.; Strickert, R.G. (Pacific Northwest Lab., Richland, WA). pp 753-760 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC06-76RL01830.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Experiments based on a modified MCC-3S test method were conducted to investigate the solubility of U(VI) hydroxide (the mineral schoepite) and Np(IV) hydrous oxides at ambient temperature. The solubility of U(VI) hydroxide was investigated in carbonate-free, oxidizing aqueous solutions in the pH range of 3 to 11. The measured concentrations of dissolved U confirm the amphoteric behavior of U(VI) hydroxide solid and the importance of anionic U(VI) solids under basic pH conditions. The effect of fluoride complexation on the solubility of Np(IV) hydrous oxide was studied in carbonate-free, near-neutral to alkaline solutions that contained 100 ppm total F. For solutions in which sodium dithionite ($Na_2S_2O_4$) and metallic Fe were used as reducing agents, the addition of 100 ppm F had no measurable effect on the solubility of Np(IV) hydrous oxide. 20 refs., 1 fig.

32358 Calculation of the elastic constants and high-pressure properties of diopside, $CaMgSi_2O_6$. Matsui, M.; Busing, W.R. (Oak Ridge National Lab., TN). *American Mineralogist;* **69**: 1090-1095(1984). Contract W-7405-ENG-26.

A computational model has been developed which describes the structure of the pyroxene mineral diopside, $CaMgSi_2O_6$, at the atomic level. The best model for the one-dimensional silicate chains permits all bond angles and the bond distances along the chain to vary. The crystal energy of the model is calculated from Coulomb, near-neighbor repulsion, bond-angle bending, and bond stretching terms. Minimizing this energy with respect to 16 structural variables, including the lattice parameters, yields a structure which reproduces the observed one reasonably well. Elastic constants were calculated which also agree well with experiment. Calculations for the model have been repeated at a simulated pressure of 50 kbar, and pressure derivatives of the elastic constants have been obtained. Calculated pressure derivatives of the lattice parameters, bond distances, and bond angles are in rough agreement with those observed experimentally. Two other models, with more constraints on the silicate chains, did not reproduce the elastic constants satisfactorily. 18 references, 1 figure, 4 tables.

32359 Raman spectroscopic investigation of the effect of H_2O on the molybdenum surface species in MoO_3/Al_2O_3 catalysts. Stencel, J.M.; Makovsky, L.E.; Sarkus, T.A.; de Vries, J.; Thomas, R.; Moulijn, J.A. (Pittsburgh Energy Technology Center, PA). *Journal of Catalysis;* **90**: 314-322(1984).

The Raman spectroscopic characterization of a set of MoO_3/Al_2O_3 catalysts containing 3 to 25 wt% MoO_3 is presented. Controlled atmosphere measurements show that the Raman spectra of these catalysts are influenced drastically by the water content of the samples. Catalysts calcined in O_2 at 500° have spectra very different from previously reported spectra. The Mo=O stretching vibration is at about 1000 cm^{-1} in calcined samples, whereas in H_2O-exposed samples the frequency is near 950 cm^{-1}. The position of the Mo=O stretching vibration is shown by repeated H_2O exposure, O_2 calcination cycles to be reversible between 950 and 1000 cm^{-1}. Models for the interaction of H_2O with the surface molybdate species are presented and discussed with respect to the Raman data. 22 references, 6 figures.

32360 Temperature determinations in the inductively coupled plasma using a Fourier transform spectrometer. Faires, L.M.; Palmer, B.A.; Engleman, R. Jr.; Niemczyk, T.M. (Los Alamos National Lab., NM). *Spectrochimica Acta, Part B: Atomic Spectroscopy;* **39B**: No. 6, 819-828(1984).

A vertical profile of iron I excitation temperature in the inductively coupled plasma was determined using spectroscopic techniques based on the Einstein-Boltzmann expression for spectral line intensity and the powerful information gathering ability of a high resolution Fourier transform spectrometer. Calculated temperature values were found to be critically dependent on the oscillator strength values chosen from the literature; however, a qualitative picture of the vertical excitation temperature gradient in the plasma was well-defined and was found to reach a maximum value in the normal analytical zone of the plasma. Excitation temperatures for iron I, nickel I, cobalt I, and vanadium I and II in the normal analytical zone of the plasma were also determined by the same method. 39 references, 2 figures, 3 tables.

32361 Thermochemistry of inorganic sulfur compounds. II. Standard enthalpy of formation of germanium disulfide. Murray, W.T.; O'Hare, P.A.G. (Argonne National Lab., IL). *Journal of Chemical Thermodynamics;* **16**: 335-341(1984).

A high-purity sample of GeS_2 was prepared by combining the elements. A fluorine bomb-calorimetric study of the reaction: $GeS_2(cr) + 8F_2(g) = GeF_4(g) + 2SF_6(g)$, gave for the standard (p^o = 101325 Pa) molar enthalpy of formation: Δ/sub f/H/sub m/°(GeS_2, cr, 298.15 K) = -(124.7 +/- 2.6) kJ x mol^{-1}. This result does not agree with most of the earlier high-temperature measurements. Two recent studies, however, give Δ/sub f/G/sub m/°(GeS_2) that agrees with the result obtained here. The standard molar Gibbs energy of formation Δ/sub f/G/sub m/°(GeS_2, cr, 298.15 K) is calculated to be -(124.2 +/- 2.6) kJ x mol^{-1}. Based

upon a comparison of bond enthalpies, the enthalpy of atomization of PbS_2, Δ/sub at/H/sub m/°(PbS_2), has been estimated to be (546 +/- 20) kJ x mol^{-1}. 35 references, 2 tables.

32362 **Energy transfer and isotopic enrichment in vibrationally pumped diatomic molecules.** DeLeon, R.L.; Rich, J.W.; Bergman, R.C.; Homicz, G.F. (Calspan Corp., Advanced Tech. Center, P.O. Box 400, Buffalo, NY 14225). pp 370-372 of Lasers '84. McLean, VA; STS Press (1984). (CONF-8411153—). Contract AC02-83ER13115.

From International conference on lasers '84; San Francisco, CA, USA (26 Nov 1984).

The preliminary results from two experiments on vibration-vibration pumped CO are reported. The first experiment is a demonstration of isotopic enrichment by vibration-vibration pumping. An ≈300°K translational temperature flowing mixture of CO, Ar and He is excited by a CO laser and the resulting non-equilibrium vibrational distribution is probed by laser induced fluorescence. In CO plus Ar mixtures, ^{13}CO enrichments of a factor of three times the natural ^{13}CO abundance are observed for high, v = 30, vibrational states. In CO plus Ar and He mixtures the ^{13}CO enrichment is reduced to approximately its natural abundance. Calculations indicate that larger He mole fractions could result in relative enrichment of the ^{13}CO isotope. The second experiment is a time and state resolved kinetics study of vibration-vibration pumped CO. A pulsed CO laser is used to produce a highly excited vibrational distribution. The vibrationally resolved overtone emission from the ground electronic state is monitored as a function of time for states v = 2 to 40. Electronic emission from the A-X band is also observed. In order to derive the kinetic rates for the various vibrational exchange processes, the data are compared with a kinetic model including all of the energy exchange terms. Preliminary calculations show reasonable agreement with the observed ground electronic state emission.

32383 **Gas phase spectroscopy near the carbon K-edge.** Eberhardt, W.; Sham, T.K. (Exxon Research and Engineering Co., Linden, NJ). *Proceedings of the Society of Photo-Optical Instrumentation Engineers;* **447**: 143-149(1983). Contract AC02-76CH00016;AC02-80ER10750.

From Conference on science with soft x-rays; Upton, NY, USA (17-19 Oct 1983).

Soft x-ray excitation involving C 1s electrons in CO, as well as aliphatic, and aromatic hydrocarbons is found to result in ionic fragmentation of the original molecule. The fragmentation pattern changes whether the C 1s electron gets ionized or excited into a Rydberg-like orbital, or into an unfilled molecular orbital. In this study the near edge C 1s absorption spectra is correlated with the observation of specific ionic fragments of the original molecules. 17 references, 7 figures.

32384 **(LA-tr—86-12) Absorption spectrum of F_2O_2.** Brodersen, P.H.; Frisch, P.; Schumacher, H.J. Translated from *Zeitschrift fuer Physikalische Chemie (Leipzig) ;* **37B**: 25-29(1937). Contract W-7405-ENG-36. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010347.

The absorption spectrum of F_2O_2 was taken between 2000 and 10,000 Angstroms (A). It is a slightly un- dulating continuum. The absorption begins at about 5900 A and increases in intensity toward short wavelengths. At 2200 A, the maximum absorption is still not attained. The extinction coefficients were determined over the entire absorption range. 2 figs., 1 tab.

32385 **(LA-tr—86-11) Kinetics of the decomposition of F_2O_2.** Schumacher, H.J.; Frisch, P. Translated from *Zeitschrift fuer Physikalische Chemie (Leipzig) ;* **37B**: 1-17(1937). Contract W-7405-ENG-36. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010271.

The thermal decomposition of F_2O_2 is examined between -60 and -25°C at pressures of 2.5 to 400 mm Hg. The reaction is a homogeneous, monomolecular one. The rate constant depends on pressure within the studied range. At -37.1°C, and at a F_2O_2 pressure of ca. 10 mm, k has a value of 1/2. At low pressures, 1/k graphed against 1/p yields a sharp deviation from a straight line. The pressure dependency, however, can be represented using the Kassel-Rice theory, if one takes 6 as the number of excited degrees of freedom, 7 x 10^{-8} cm as the molecule diameter and 17,300 cal for q/sub o/. It develops that energy compensation occurs at practically every impact of two F_2O_2 molecules. 4 refs.

32386 **(LA-tr—86-9) Thermal decomposition of fluorine oxide F_2O_2. Preliminary communication.** Frisch, F.; Schumacher, H.J. Translated from *Zeitschrift fuer Physikalische Chemie (Leipzig) ;* **34B**: 322(1936). Contract W-7405-ENG-36. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010349.

In investigations of the kinetic and photochemical behavior of the fluorine oxides we found that F_2O_2 decomposes in a homogeneous, monomolecular reaction following a first-order equation. We worked between the temperatures -25 and -60°C. By spectroscopic and chemical investigations we determined that the gases into which F_2O_2 decomposes are not FO, as stated elsewhere, but an equimolecular mixture of F_2 and O_2. Accordingly, analogously to ClO, if it exists at all FO seems to have only a very brief lifespan. 3 refs.

4003 Organic Chemistry

REFER ALSO TO CITATION(S) 31300, 31311, 31332, 31390, 31398, 31402, 31648, 31650, 32034, 32247, 32354, 32363, 32823, 32827, 32828, 32830

32367 **(CONF-860425—26) Distance dependent rates of photoinduced charge separation and dark charge recombination in fixed distance porphyrin-quinone molecules.** Wasielewski, M.R.; Niemczyk, M.P. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 16p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010511.

From 191. American Chemical Society national meeting; New York, NY, USA (13 Apr 1986).

Three zinc tetraphenylporphyrin-anthraquinone derivatives were prepared in which the edge-to-edge distances between the porphyrin and quinone π systems are fixed by a rigid hydrocarbon spacer molecule. Triptycene, trans-1,2-diphenylcyclopentane, and adamantane were used to fix the porphyrin-anthraquinone distance at 2.5, 3.7, and 4.9 A, respectively. These molecules possess 1,2, and 3 saturated carbon atoms, respectively, between the porphyrin donor and the quinone acceptor. Rate constants for photoinduced electron transfer from the lowest excited singlet state of the zinc tetraphenylporphyrin donor to the anthraquinone acceptor were measured. In addition, the corresponding radical ion pair recombination rate constants for each of these molecules were also determined. The rate constants for both photoinduced charge separation and subsequent radical ion pair recombination decrease by approximately a factor of 10 for each saturated carbon atom intervening between the porphyrin donor and the quinone acceptor. These results are consistent with a model in which the rate of electron transfer is determined by weak mixing of the σ orbitals of the saturated hydrocarbon spacer with the π orbitals of the donor and acceptor. 22 refs., 5 figs.

32368 **(LBL—21104) Thermodynamic properties of hydrocarbons.** Parker, T.E.; Sawyer, R.F.; Oppenheim, A.K. (Lawrence Berkeley Lab., CA (USA)). Feb 1986. Contract AC03-76SF00098. 200p. NTIS, PC A09/MF A01; 1; GPO Dep. File Number DE86010401.

A numerical technique for calculating thermodynamic properties of non-polar pure substances is presented. It is based on the use of the extended principle of corresponding states for the determination of P-V-T relations and their reduction to the Benedict-Webb-Rubin equation of state. Virial coefficients are deduced and combined with specific heat data to determine the internal energy, entropy, and bulk modulus of elasticity. On this basis an algorithm is developed to calculate properties for a state fixed by any two independent parameters. The technique thus established is applied to normal paraffins, and the results for all species, from methane to hexadecane, are presented in tabular and graphical form.

32369 **Characterization of matrix-isolated cyclopropen-3-yl by EPR spectroscopy.** Closs, G.L.; Redwine, O.D. (Univ. of Chicago, IL). *Journal of the American Chemical Society;* **108**: No. 3, 506-507(5 Feb 1986).

The simplest member of the series of fully conjugated cyclic radicals with the general formula C/sub 2n+1/ H/sub 2n+1/ (n = 1,2,3,...), cyclopropen-3-yl(1), has been the subject of much attention by theorists but has not yet been characterized by any spectroscopic method although its presence has been inferred from voltammetric measurements. Several alkyl-substituted derivatives have been detected by ESR and optical spectroscopy showing interesting structural and dynamic properties but attempts to obtain spectra of the parent compound have so far met with failure. In this paper the EPR spectrum of 1 is reported as observed in matrix isolation between 20 and 140 K. 8 references, 1 figure, 1 table.

32370 **First insertion of NO into a transition-metal cluster-carbon bond: regioselective formation, structure, and reactions of the first alkanenitrile oxide complexes.** Goldhaber, A.; Vollhardt, K.P.C.; Walborsky, E.C.; Wolfgruber, M. (Univ. of California, Berkeley). *Journal of the American Chemical Society;* **108**: No. 3, 516-518(5 Feb 1986).

The chemistry of NO in the presence of transition metals is receiving considerable current attention because of its role in air pollution, its potential in organic synthesis by carbon-nitrogen bond formation, and an increasing interest in its basic features. The nitrosyl cation has been reacted with many mono and polynuclear metal systems, leading mainly to substitution and reduction. Insertion into alkyl and aryl metal bonds in mono-metallic complexes is documented. The unprecedented title reaction and some preliminary chemistry of the products are reported here. 27 references, 1 figure.

32371 **Zirconoxycarbene complexes of ruthenium - reduction of coordinated CO in the reaction of a Zr-Ru compound with H_2.** Casey, C.P.; Palermo, R.E.; Rheingold, A.L. (Univ. of Wisconsin, Madison). *Journal of the American Chemical Society;* **108**: No. 3, 549-550(5 Feb 1986).

Compounds have been synthesized with directly bonded early and late transition metals such as $Cp_2Zr[Ru(CO)_2Cp]_2$ in the hope of cleaving the metal-metal bond with H_2. The resulting mixture containing reactive hydridic M-H and acidic M-H units might be a powerful reducing system for polar molecules including CO. Evidence is presented for a circuitous stepwise conversion of the complex into Ru-H and Zr-H units and for the reduction of coordinated CO to a formyl or zirconoxy carbene group. 8 references, 1 figure.

32372 **Carbon-14 NMR spectrum (68 MHz) of 2,6-dinitrophenol in CDCl3 and the temperature variation of the chemical shifts in reference to intramolecuar hydrogen bond.** Aihara, A.; Matsushita, K. *Denki Tsushin Daigaku Gakuho;* **36**: No. 1, vp(Sep 1985).

H-1 as well as C-13 NMR spectra, at 270 MHz and 68 MHz, respectively, were observed with 2,6-dinitrophenol and some related substances in order to get a further insight into the nature of intramolecular hydrogen bond formed. Temperature variation of the C-13 NMR signals of 2,6-dinitrophenol revealed an interesting feature in the chemical shifts of phenyl carbons which suggests a close relationship between chemical shift of carbons and pi-electron densities on the atoms being induced by formation and breakage of the intramolecular hydrogen bond.

32373 **Dielectric effects in biopolymers: the theory of ionic saturation revisited.** Hingerty, B.E.; Ritchie, R.H.; Ferrell, T.L.; Turner, J.E. (Oak Ridge National Lab., TN). *Biopolymers;* **24**: 427-439(1985). Contract W-7405-ENG-26.

Electrostatic effects are believed to determine the molecular structure and function of macromolecules in many ways. In metallo-based enzymes and in metal-macromolecule interactions in solution, these effects may predominate. In order to tackle metal ion-nucleic acid interactions theoretically, a modification of Debye's distance-dependent dielectric function first proposed more than 50 years ago is proposed. This function more closely approximates physical reality at small interatomic separations. The theory proposed here yields a dielectric function that gives reasonable agreement with experimental data in preliminary calculations. 39 references, 4 figures, 6 tables.

32374 **Homogeneous catalytic hydrogenation. 4. Regioselective reduction of polynuclear heteroaromatic compounds catalyzed by hydridochlorotris(triphenylphosphine)ruthenium(II).** Fish, R.H.; Tan, J.L.; Thormodsen, A.D. (Lawrence Berkeley Lab., CA). *Organometallics;* **4**: No. 10, 1743-1747(1985). Contract AC03-76SF00098.

The selective reduction of polynuclear heteroaromatic nitrogen compounds such as quinoline, 1, 5,6-benzoquinoline, 2, 7,8-benzoquinoline, 3, acridine, 4, phenanthridine, 5, and indole, 7, and in one case the sulfur heterocycle benzothiophene, 6, with hydridochlorotris(triphenylphosphine)ruthenium(II) as catalyst, under rather mild hydrogenation conditions, provided in each case the corresponding saturated nitrogen- or sulfur-containing ring compound with reasonable conversion rates and total yields. In addition, it was found that several compounds would inhibit the reduction of 1, to 1,2,3,4-tetrahydroquinoline, 8, including 8 itself, as well as 2,7,9 (2-methylpyridine), 10 (3-methylpyridine), and 11 (carbazole). Compounds 3 and 6 did not inhibit the rate of reduction. These inhibitions are seen as effects of competition for binding to the catalyst metal center, this competitive binding being affected by steric constraints and electronic effects such as basicity of the substrates. The substitution of deuterium gas for hydrogen gas in the reduction of 1 provided information on the reversibility of the hydrogenation step and implies a cyclometalation reaction is occurring leading to exchange of the 8-position of the product. Additional deuterium experiments starting with 8 instead of 1 indicate that the catalyst can partially dehydrogenate 8 to form an imine intermediate leading to deuterium exchange at the 2-position. 8 references, 1 figure, 3 tables.

32375 **Intramolecular excimer formation and energy migration in head-to-head polystyrene.** Kyle, B.R.M.; Kilp, T. (Univ. of Notre Dame, IN). *Polymer;* **25**: No. 7, 989-994(Jul 1984).

Head-to-head polystyrene (HH-PS), in which the phenyl rings are separated by either two or four carbon atoms, displays predominantly fluorescence from monomeric units. No excimer emission is observable even when the polymer is dissolved in increasingly thermodynamically poorer solvents. This is strongly suggestive that excimer formation in normal head-to-tail polystyrene (HT-PS) occurs primarily between nearest-neighboring chromophores. Intramolecular energy migration is shown to be negligible in both fluid and solid solutions of HH-PS. This is in direct contrast to the case with HT-PS in fluid solutions in which an energy migration coefficient of 7.5×10^{-8} cm^2 s^{-1} and an energy migration frequency of 4.1×10^{11} s^{-1} were determined. 36 references, 5 figures, 1 table.

4004 Electrochemistry

REFER ALSO TO CITATION(S) 32170, 32329

32376 **(PB—86-157864/XAB) Photoelectrochemical reduction of carbon dioxide. Annual report, May 1984-April 1985.** Chandrasekaran, K.; Bockris, J.O. (Texas A and M Univ., College Station (USA). Dept. of Chemistry). Jul 1985. 68p. NTIS, PC A04/MF A01.

Surface states at semiconductor-electrolyte interfaces were determined under illumination for CdTe, GaP and Si. The faradaic reaction involved was photoelectrochemical reduction of CO_2 on CdTe and GaP and H_2 evolution on Si. New equivalent circuits are proposed to represent the semiconductor-electrolyte interface under illumination. Surface state density is calculated per unit area at a given bias potential from integral surface state capacitance. Surface states at Si - aqueous H_2SO_4 interface act as recombination centers for the photogenerated electron hole pair annihilation. Surface states at CdTe-electrolyte interface act as faradaic mediators for CO_2 reduction. It is proposed that adsorbed ions and radicals induce surface states. Potential of zero charge was determined for semiconductor electrolyte interfaces using Herbert pendulam and the results are discussed for several interfaces.

32377 Electron attachment identifies carcinogens. *Chemical and Engineering News;* 32-33(17 Sep 1984).

The rate of electron attachment to a compound dissolved in a nonpolar solvent identifies carcinogens and noncarcinogens with sensitivity and specificity comparable to the Ames Salmonella bioassay, according to George Bakale, a professor in the radiology department, Case Western Reserve University, Cleveland. Bakale described a pulse conductivity technique for measuring the rate of electron attachment to compounds and the results of studies of known carcinogens and noncarcinogens dissolved in isooctane or cyclohexane. A positive response occurs when that rate is equal to the diffusion-controlled rate of electron attachment, indicating that the chemical can interact efficiently with electron-rich molecules such as deoxyribonucleic acid (DNA), the molecule generally considered to be the target for the initiation of chemical carcinogenesis. Using that criterion, the technique correctly identifies 55 of 65 known carcinogens and 48 of 55 noncarcinogens. That translates to a sensitivity (correct identification of carcinogens) of 85%. The pulse conductivity technique is a relative of pulse radiolysis. The researchers irradiate the solution under study with a short pulse of 1-MeV electrons, which creates a homogeneous distribution of electrons and ions. The solution is between parallel plates across which an electric potential is applied. The electrons in solution move in the electric field setting up a current. The decay of the current follows pseudo-first-order kinetics allowing a simple calculation of the rate of electron attachment from the half-life of the electrons in solution.

4005 Photochemistry

REFER ALSO TO CITATION(S) 32376, 32384

32378 (DOE/ER/01715—249) [Studies of chemical reactions in solid matrices]. Final report, December 1,, 1979-November 30, 1984. Willard, J.E. (Wisconsin Univ., Madison (USA)). Dec 1984. Contract AC02-76ER01715. 68p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010213.

This program, which has been supported for 35 years by the Atomic Energy Commission and its successor agencies, has produced significant advances in the understanding of the mechanisms of: (1) chemical activation by nuclear processes; (2) radiation chemistry; and (3) photochemistry. It has advanced knowledge of the reactions of electrons, hydrogen atoms and small free radicals, particularly in solids at cryogenic temperatures. It has applied radioisotopes as a tool in the solution of a number of chemical problems, has developed useful new techniques, and has contributed to the training of approximately 150 scientists at various levels. This final report includes a review of the evolution of areas of research emphasized, tabulations of the publications (chronologically and by research area) and Ph.D. theses resulting from the program, and tabulations of the research personnel (by academic category, by dates in the program and by subsequent employment).

32379 Solute-induced photo-ionization of nonpolar liquids. McDonald, D.B.; Sauer, M.C. Jr. (Argonne National Lab., IL). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Electrical Insulation;* **EI-20**: No. 2, 371-374(Apr 1985). Contract W-31-109-ENG-38.

Transient dc conductivity measurements of anthracene solutions in cyclohexane have provided evidence for solvent ionization following irradiation with 248 nm excimer laser pulses. A mechanism resulting in a cyclohexane cation and an anthracene anion as near neighbors can explain the experimental observations: a high mobility species, 7 to 8 absorbed photons per solute molecule, intensity dependence, and absence of enhanced hydrogen generation. The nature of the high-mobility species is discussed and the contribution of geminate ions to transient dc conductivity measurements is analyzed. A photo-ionization apparatus with 20 ps time resolution is being developed to observe the transient ions spectroscopically. Such a system may enable observation of solute-induced ionization in solvents having normal mobility cations. 13 references, 4 figures.

32380 Twenty-two carbon homologue of 11-cis retinal. Photophysical and photochemical properties. Das, P.K.; Becker, R.S. (Univ. of Notre Dame, IN). *Photobiochemistry and Photobiophysics;* **39**: No. 3, 313-318(1984).

Results concerning absorption-emission spectra and fluorescence quantum yields at 77 and 298 K, triplet absorption spectra, and quantum yields of intersystem crossing and photoisomerization at 298 K, are presented for 11-cis B-apo-14'-carotenal (C_{22}-Ald), the immediate higher homologue of 11-cis retinal. The absorption spectra are characterized by two band-systems with maxima at 390-400 and 270-280 nm, respectively. Upon cooling from 298 to 77 K, the intensities of these two band-systems undergo changes in opposite directions indicating 12-s-cis:12-s-trans conformational changes. No intermediate band-system analogous to the one located at 270-310 nm in cis retinals is observed for 11-cis C_{22}-Ald. In nonpolar hydrocarbon solvents at room temperature, quantum yields of fluorescence (0.01), intersystem crossing (0.6) and photoisomerization (0.4) are all quite pronounced. The photophysical and photochemical properties of 11-cis C_{22}-Ald are discussed in the light of similarities and dissimilarities with those of all-trans C_{22}-Ald and 11-cis retinal under comparable conditions. 30 references, 5 figures, 1 table.

32381 Photochemistry and photophysics of phenylmethyl radicals. Bromberg, A.; Schmidt, K.H.; Meisel, D. (Argonne National Lab., IL). *Journal of the American Chemical Society;* **106**: 3056-3057(1984). Contract W-31-109-ENG-38.

The photophysics of arylalkyl radicals, notably that of the prototype benzyl radical ($PhCH_2$/sub ./), have been extensively studied. Fluorescence lifetimes and quantum yields have been experimentally measured in solid matrices at low temperatures and theoretical calculations have estimated the energy levels and the various decay modes of a variety of substituted benzyl radicals. Fluorescence from the closely related diphenylketyl radical has also been observed in a glassy matrix as well as at room temperature. For the ketyl radical the fluorescence lifetime has decreased from $\sim$ 20 to $\sim$ 2 ns on increasing the temperature from 77 K to room temperature, indicating a possible photochemical reaction of the excited state of the radical at the higher temperature. While the fluorescence lifetime of the benzyl and its analogue radicals at 77 K is in the range of 1.0 +/- 0.5 μs, no information is available in the literature on their fluorescence lifetime at higher temperatures. In fact, information on the photochemistry and photophysics of radicals in liquid solutions is very scarce. To bridge this gap a systematic study of such systems has been initiated. In the present communication, the room temperature lifetime, excited-state doublet-doublet and fluorescence spectra of the diphenylmethyl radical are reported as well as the photochemistry of its triphenylmethyl homologue. 18 references, 2 figures.

32382 Selective quenching during half-collisions of laser excited xenon atoms. Bowering, N.; Keto, J.W. (Dept. of Physics, Univ. of Texas at Austin, Austin, TX 78712). pp 373-379 of Lasers '84. McLean, VA; STS Press (1984). (CONF-8411153—). Contract FG05-84ER13191.

From International conference on lasers '84; San Francisco, CA, USA (26 Nov 1984).

Xenon atoms are excited to $5p^56p$ during a collision by two-photon lasers excitation at 2800 Torr. The half-collision dynamics is probed by line shape measurements of the laser-induced fluorescence. The vuv excimer emission is found to measure directly the excitation probability. By observing infrared 6p - 6s radiation of dissociated excited pairs simultaneously, we obtain from the ratio of Ir/vuv intensity the probability for subsequent fluorescence of excited pairs as a function of laser frequency. This probability is found to decrease significantly as the laser is tuned into the line wing corresponding to excitation of pairs during a collision at small internuclear separations R. We interpret this strong decrease with decreasing R as an increase in quench rate due to a potential crossing with the repulsive $6s'[1/2]_1$ 0+g state. A Landau-Zener model for the first half-collision yielding a "staircase"- dependence of quench rate on R is in qualitative agreement with the data. Since subsequent full collisions occur identically for all dissociating states independent of where on the excited potential curve they were created, the comprises a direct probing of the selective effect of the first half-collision on deactivation.

32383 Adiabatic approach in the theory of polyatomic photodissociation: Application to C_2N_2. Lester, W.A.; Kresin, V.Z.; Dateo, C.E. (Materials and Molecular Res. Div., Lawrence Berkeley Lab., Univ. of California, Berkeley, CA 94720). pp 499-507 of Lasers '84. McLean, VA; STS Press (1984). (CONF-8411153—). Contract AC03-76SF00098.

From International conference on lasers '84; San Francisco, CA, USA (26 Nov 1984).

An adiabatic method for nuclear motion has been developed and applied to single-photon predissociation of C_2N_2. The theoretical predictions are in good accord with recent measured product energy distributions.

4006 Radiation Chemistry

REFER ALSO TO CITATION(S) 32310, 32363, 32378

32384 (HMI-B—417) HMI Department of Radiation Chemistry: Results of scientific activities in 1984. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (Germany, F.R.). Bereich Strahlenchemie). 1985. 72p. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751727.

In the radiation chemistry department of the Hahn-Meitner-Institute in Berlin, 4 subjects are treated largely the progress of which made in 1984 is herein reported: 1) Interface processes and energy conversion (reaction pathways of photoinduced charge carriers and their in energy conversion mechanisms); 2) Pulse radiolysis (generation and investigation of shortlived chemically quick-reacting particles); 3) Kinematics (reciprocal action with ion, atom and molecule collisions; clarification of the dynamics of chemical reactions); 4) Insulators and plastics (physical and chemical primary processes when these materials are subjected to high-energy radiation, light or UV light). A list of publications and lectures is added to complement the description of results gained from R and D work. (BR).

32385 Resonant photoemission in MnF_2. Hayes, R.G.; Sham, T.K. (Department of Chemistry and Radiation Research Laboratory, University of Notre Dame, Notre Dame, Indiana 46556). *Journal of Chemical Physics;* **84**: No. 12, 7052-7054(15 Jun 1986).

Photoelectron spectra are reported for MnF_2 using the National Synchrotron Light source radiation (NSLS) as excitation radiation. Resonance structures, defined as the enhancement of intensity are discussed. (AIP)

32386 Pulse radiolysis studies of alkaline Fe(III) and Fe(VI) solutions. Observation of transient iron complexes with intermediate oxidation states. Rush, J.D.; Bielski, H.J. (Brookhaven National Lab., Upton, NY). *Journal of the American Chemical Society;* **108**: No. 3, 523-525(5 Feb 1986). Contract AC02-76CH00016.

The first spectroscopic evidence for complexes containing iron formally in the IV and V oxidation states in the presence of a simple ligand, i.e., OH^- and $P_3O_7^{4-}$ in alkaline solution is reported. These transient species are obtained by pulse radiolysis of alkaline ferric (Fe(III)) and ferrate (Fe(VI)) solutions by using the hydroxyl radical or its conjugate base, O^-, and the aquated electron, e/sub aq/$^-$, as the respective oxidizing and reducing agents. 18 references, 1 figure.

32387 Effects of ionizing radiations on synthetic organic ion exchangers. Pillay, K.K.S. (Los Alamos National Lab., NM, USA). *Journal of Radioanalytical and Nuclear Chemistry;* **97**: No. 1, 135-210(Jan 1986).

Effects of ionizing radiations on organic ion exchangers are recognized as a vexing problem in the processing of special nuclear materials and high specific activity radioactive waste forms. An extensive literature survey, started in 1976 and updated periodically, indicates that radiation decomposition of ion exchange materials has the potential for a variety of undesirable consequences. It is also apparent from this survey that systematic efforts to identify and resolve these problems and to develop radiation resistant ion exchangers are extremely limited. There is, however, widely scattered information in the literature that is useful in designing and operating ion-exchange-based process systems with reasonable assurance of safety. The compilation of experimental data presented in this paper can contribute to better design and safer operation of synthetic organic ion exchange systems at nuclear material processing facilities.

32388 Generalized model for the analysis of groundwater radiolysis. Nicolosi, S.L. (Battelle Columbus Labs., OH). pp 632-640 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

A generalized groundwater radiolysis model which is under development at Battelle-Columbus is described. This model uses a 55 reaction basis set for the radiolysis of the solvent. The basis set of reactions was chosen from the literature after comparing several descriptions against experimental data. This basis set has been augmented with 17 additional reactions to allow the description of the radiolysis of groundwater containing iron. The development of this mechanism is decribed, and comparisons with experimental data are shown. 22 refs., 6 figs.

32389 Reactions of energetic carbon-11 in homologous gas-phase halocarbons. Lambrecht, R.M.; Wolf, A.P. (Brookhaven National Lab., Upton, NY). *Journal of Physical Chemistry;* **88**: No. 10, 2076-2082(1984).

The reactions of energetic ^{11}C atoms were investigated in 34 halocarbons containing O_2 scavenger. ^{11}CO yields were enhanced and $^{11}C_2H_4$ yields were dramatically reduced by the presence of a halogen in the reaction mixture. $^{11}C_2H_4$ yields, like $^{11}C_2H_2$ yields, are seemingly influenced by the electron density in the collision complex. Product yields and a kinetic model add further evidence to the mechanism of formation of $^{11}C_2H_4$ via the insertion of energetic ^{11}CH into C-H bonds in a collision complex, followed by the decomposition of the complex to products. F, Cl, Br, and I appear to divert $^{11}C(^1D)$ from forming methyne by halomethyne formation and/or spin conversion of $^{11}C(^1D)$ to $^{11}C(^3P)$. The corresponding chloroethylene which should arise from chloromethyne insertion into CH_3Cl or a vinyl halide radical precursor was found in only 0.3% yield. 33 references, 5 figures, 4 tables.

4007 Radiochemistry And Nuclear Chemistry

REFER ALSO TO CITATION(S) 31501, 31503, 32334, 32824

32390 (AEEW-R—1742) Decontamination of a pressurised suit area at AEE Winfrith. Part 1. Dry suction cleaning and treatment with chemical foams. Bond, R.D.; Rankin, J.D.; Robinson, D.H.; Sanders, M.J. (UKAEA Atomic Energy Establishment, Winfrith). Apr 1984. 33p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702025.

Dry suction cleaning and chemical foam treatment were used on a plutonium oxide contaminated area. Details of the equipment and reagents are given together with the results. Average levels of contamination by one application were reduced by over 80 percent, and airborne levels by more than 99 percent.

32391 (AEEW-R—1865) Decontamination of a fuel transport flask using chemical foams. Bond, R.D. (UKAEA Atomic Energy Establishment, Winfrith). May 1985. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702026.

Traditional methods of flask decontamination are labour-intensive and depend on operator skills. A chemical foam technique has been evaluated as an alternative method. It is simple and effective and offers savings in manpower, and advantages in control over contamination and arisings.

32392 (DOE/ER/40048—102-L4, pp 62-63) **Short-lived radionuclides for biomedical research.** Kremer, P.; Krohn, K.A.; Link, J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

This past year the authors have continued to develop short-lived radioisotopes for biomedical research in the School of Medicine at the University of Washington. ^{18}F is being produced using the Tandem Van de Graaff accelerator by bombarding gaseous ^{20}Ne with 15 MeV deuterons. Added F_2 (1%) reacts with the nucleogenic ^{18}F to produce $F^{18}F$, a useful organic fluorinating agent. The authors are producing approximately 300 mCi of ^{18}F per 6 μA hours and can transfer 125 mCi from the target to a chemical reaction vessel in a hot cell. The target effluent contains no detectable ^{18}F.

32393 **(FRNC-TH—2252) Carbon-11 labelled phosgene new synthesis - medical interest.** Landais, P. (Paris-11 Univ., 91 - Orsay (France)). Sep 1985. 111p. (In French). NTIS (US Sales Only), PC A06/MF A01. File Number DE86751780.

This thesis describes a new synthesis of high specific radioactivity carbon-11 labelled phosgene. The latter is an important precursor for the labelling of radiopharmaceuticals used in Positron Emission Tomography. The synthesis is carried out in 10 minutes. First, the carbon-11 labelled methane ($^{11}CH_4$) is chlorinated into carbon tetrachloride on pumice impregnated with copper (II) chloride. A photochemical process had previously been studied but this reaction was strongly inhibited. Then the ^{11}C-carbon tetrachloride is oxidized into ^{11}C-phosgene on hot stainless. The ^{11}C-CGP 12177 has been labelled from this new ^{11}C-Phosgene synthesis for receptor studies which require high specific radioactivity.

32394 **(IPEN-Pub—71) Method for preparation of uranium hydride.** Gorski, M.S.; Goncalves, M.; Mirage, A.; Lima, W. de. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 10p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702003.

A method for preparation of uranium hydride starting from hydrogen and uranium is described. In the temperature range of 250° up to 350°C, and pressures above 10 torr, hydrogen reacts smoothly with uranium turnings forming a fine black or dark gray powder (UH_3). Samples containing a significant amount of oxides show a delay before the reaction begins.

32395 **Formation of actinide hexafluorides at ambient temperatures with krypton difluoride.** Asprey, L.B.; Eller, P.G.; Kinkead, S.A. (Los Alamos National Lab., NM). *Inorganic Chemistry;* **25**: No. 5, 670-672(27 Feb 1986).

A second low-temperature agent, krypton difluoride, for generating volatile plutonium hexafluoride is reported (dioxygen difluoride is the only other reported agent). Plutonium hexafluoride is formed at ambient or lower temperature by the treatment of various solid substrates with krypton difluoride. Volatilization of uranium and neptunium from solid substrates using gaseous krypton difluoride is also reported for the first time. The formation of actinide hexafluorides has been confirmed for the reaction of krypton difluoride in anhydrous HF with UO_2 and with uranium and neptunium fluorides at ambient temperatures. Treatment of americium dioxide with krypton difluoride did not yield americium hexafluoride under the conditions studied. 15 references, 2 figures.

4008 Combustion, Pyrolysis, And High-temperature Chemistry

REFER ALSO TO CITATION(S) 31368, 31369, 32516

32396 **(AD-A—164028/3/XAB) Structure of counterflow diffusion flames burning multicomponent fuels.** Hamins, A.; Seshadri, K. (California Univ., San Diego, La Jolla (USA). Dept. of Applied Mechanics and Engineering Sciences). 1984. 10p. NTIS, PC A02/MF A01.

The structure of a diffusion flame stabilized between counterflowing streams of a multicomponent fuel containing N components and an oxidizing gas stream is analyzed. It is presumed that each component of the fuel reacts only with the oxidizer, and does not influence the kinetics of pyrolysis or oxidation of the other components. The chemical reaction between each component of the fuel and the oxidizer is approximated as a one-step process with the activation energy for the reaction being large in comparison to the thermal energy in the flame. The near equilibrium regime is analyzed. The equation governing the inner reaction zone is integrated to obtain an explicit analytical expression for the Damkohler number at extinction. It is shown that the critical conditions of diffusion-flame extinction (i.e. velocity gradient and oxidizer concentration in the oxidizing stream) for multicomponent fuels cna be predicted if the overall chemical kinetic rate parameters characterizing the gas-phase oxidation of single-component fuels are known. To test the validity of these predictions, experiments were performed on diffusion flames stabilized above heptane, toluene, methanol and a number of homogeneous solutions (with different proportions of the components of these fuels). For solutions of heptane and toluene the theoretical predictions were found to be in excellent agreement with the experimental measurements.

32397 **(AD-A—164239/6/XAB) Transition to detonation in a model problem.** Stewart, D.S. (Cornell Univ., Ithaca, NY (USA)). 1985. 36p. NTIS, PC A03/MF A01.

It is shown, within the context of a model problem, how an initial low-Mach-number combustion wave develops into a detonation when subjected to an externally applied gasdynamic disturbance. Explicit criteria are given that the external disturbance must satisfy in order for transition to be achieved. The governing equations are the unsteady equations for an ideal reacting gas. The reaction is assumed to be fuel going into product plus heat. The reaction terms are modeled that appear in the energy and species equations by using an ignition temperature, flame-sheet model that is derived from Arrehnius kinetics in the limit of large activation energy. A small-amplitude theory is then used to take advantage of the standard techniques of linear and nonlinear acoustics by assuming that the heat released during combustion is small. A description of one of the essential criteria for transition follows. The initial disturbance applied to the reacting front is comprised of right-going and stationary progressive waves. Each wave, in isolation, produces a temperature, pressure field. For transition to detonation to occur it is necessary that the progressive wave, traveling in the direction of the ultimate detonation, produce a temperature that is equal to or greater than the ignition temperature. In particular, an example is given of a shock overtaking and accelerating an unsteady deflagration. In this case the criteria requires that the shock strength exceeds a critical value in order for transition to occur.

32398 **(DOE/ER/13282—2) Aromatics oxidation and soot formation in flames. Progress report for year beginning August 15, 1985.** Howard, J.B. (Massachusetts Inst. of Tech., Cambridge (USA). Dept. of Chemical Engineering). 1986. Contract FG02-84ER13282. 5p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010585.

Kinetics and mechanisms of aromatics oxidation and soot formation in flames are being studied by measuring profiles of soot particle size and number concentration, stable and radical gaseous species concentrations, and temperature in premixed flat flames at 2.67 kPa. Net reaction rates calculated from these measurements are used to test mechanisms of soot formation and oxidation of aromatic species. The technique for measuring radical species is molecular-beam sampling with on-line mass spectrometry, which also provides stable species data. The latter are supplemented by the data from microprobe sampling, and optical methods are being considered for supplementing the H-atom and/or OH-radical measurements. In order to utilize extensive data from previous and current molecular beam mass spectrometry research in this laboratory, the experimental conditions are chosen to match those of the other work.

32399 **(UCRL—91994) Role of the radical pool in combustion.** Creighton, J.R.; Oppenheim, A.K. (Lawrence Livermore National Lab., CA (USA); California Univ., Berkeley (USA)). 1985. Contract W-7405-ENG-48. 11p. (CONF-850830—8). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010159.

From 10. international colloquium on dynamics of explosions and reactive systems; Berkeley, CA, USA (4 Aug 1985).

We present numerical solutions of the detailed chemical kinetics mechanisms for the reactions of hydrogen with fluorine and oxygen on a phase plane where temperature is plotted vs the concentration of one of the radicals, F or H. We observe that for given initial reactant concentrations, all solutions follow a common path, after an initial transient, regardless of initial temperature or initial radical concentration. We then analyze the reaction mechanism and find that the rate equations for radical species rapidly reach a stable steady state that couples all of the radicals into a pool. The pool concentration then grows until onset of a reaction that consumes two radicals, resulting in a steady state of the entire pool. Further growth of the pool is due entirely to the temperature dependence of the steady state, which has the form of an equilibrium constant. We show that the rate of temperature increase is proportional to the radical pool concentration, particularly its steady-state value. 26 refs., 3 figs.

32400 Numerical analysis of SSME preburner injector atomization and combustion processes. Liang, P.Y.; Jensen, R.J.; Chang, Y.M. (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA). pp 9 of AIAA, Aerospace Sciences meeting. Reno, NV; AIAA (1986). (CONF-860130—).

From 24. AIAA aerospace science meeting; Reno, NV, USA (6 Jan 1986).

The coaxial spray injection and combustion flowfields of a Space Shuttle Main Engine preburner injector element have been analyzed using a three-phase numerical code. The processes of atomization, evaporation, secondary droplet breakup, and multispecies chemistry, as well as turbulent diffusion, are included. The model produced realistic pictures of the complex internal flowfield, including liquid jet length, spray shape, flame-zone size and characteristics, and predicted temperatures that seem to be in agreement with test data envelopes. It predicted an external group combustion type of flame. Salient combustion and mixing features are discussed and sources of uncertainty are pointed out for future studies. 12 references.

32401 Catalytic gasification: Isotopic labeling and transient reaction. Saber, J.M.; Falconer, J.L.; Brown, L.F. New York, NY; American Institute of Chemical Engineers (1985). 19p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017. Contract FG22-82PC50798.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

Temperature-programmed reaction was used with labeled isotopes (^{13}C and ^{18}O) to study interactions between carbon black and potassium carbonate in pure He and 10% CO_2/90% He atmospheres. Catalytic gasification precursor complexes were observed. Carbon and oxygen-bearing carbon surface groups interacted with the carbonate above 500 K to form surface complexes. Between 500 K and 950 K, and in the presence of gaseous carbon dioxide, the complexes promoted carbon and oxygen exchange between the gas-phase CO_2 and the surface. Oxygen exchanged between the surface complexes; but carbon did not exchange between the carbonate and the carbon black. As the temperature rose, the complexes decomposed to produce carbon dioxide, and catalytic gasification then began. Elemental potassium formed, and the active catalyst appears to alternate between potassium metal and a potassium-oxygen-carbon complex.

32402 Controlled transition to cellular flame fronts. Erneux, T.; Matalon, M. New York, NY; American Institute of Chemical Engineers (1985). 18p. (CONF-841121—). American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017.

From AIChE annual meeting; San Francisco, CA, USA (25 Nov 1984).

The authors propose a nonlinear control mechanism to reduce flame instabilities. An instability associated with the formation of cellular flames is known to occur when the mass diffusivity of the deficient reactant in a combustible mixture is sufficiently larger than the heat diffusivity of the mixture. The transition from the smooth front to the cellular structure can be analyzed by deriving an evolution equation for flame front disturbances. This nonlinear equation depends on the position R of the flame, which is a function of time controlled by the underlying prescribed flow. The authors consider both linear and time-periodic functions R(t) and show that the transition to cellular structures may be either considerably delayed or eliminated.

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4201 General Engineering

REFER ALSO TO CITATION(S) 33467

32403 (LA-UR—86-1363) Non-ending helium story. Hammel, E.F.; Krupka, M.C.; Williamson, K.D. Jr. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 15p. (CONF-860437—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010192.

From 11. international cryogenic engineering conference; Berlin, F.R. Germany (22 Apr 1986).

Why an adequate supply of helium is of importance to cryoengineering is obvious to everyone present at this conference. Why there is a non-ending helium problem - or more specifically why helium supply problems have arisen in the past, why they may arise again in the future, what are those problems and what solutions appear to exist - is more complicated. To answer these questions this paper is divided into three sections: resource availability, the demand for helium and the supply of helium. 17 refs.

32404 (SAND—85-0760C) Optical studies of chemical energy release during shock initiation of granular explosives. Setchell, R.E. (Sandia National Labs., Albuquerque, NM (USA)). 1985. Contract AC04-76DP00789. 33p. (CONF-850830—9). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010469.

From 10. international colloquium on dynamics of explosions and reactive systems; Berkeley, CA, USA (4 Aug 1985).

Achieving a predictive understanding of shock growth to detonation in granular explosives requires an accurate description of the temporal and spatial behavior or chemical energy release following shock compression. Direct experimental observations of the complex mechanisms involved are very difficult, and global reaction rates are typically inferred from pressure or particle velocity measurements. In the present study, visible emission from an explosive/window interface is examined using instrumentation that provides spectral, temporal, and spatial resolution. This instrumentation includes an image-converter streak camera to record histories of emission intensities dispersed by a 0.25-m specrometer, an image-converter framing camera to record multiple images of a highly magnified area of the explosive surface, and a channel intensifier tube to greatly enhance the sensitivity of either camera. Planar impact experiments were conducted on a compressed-gas gun facility using samples of the explosives hexanitrostilbene and PBX-9404. The streak emission records show a distinct structure within the earliest observable emission.

32405 (SAND—85-1937C) Two-dimensional continuum model for jointed media with orthogonal sets of joints. Chen, E.P. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 6p. (CONF-860609—14). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010460.

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

This investigation involves the development of a two-dimensional continuum model for the description of jointed media. Specific application of the model developed here is for the potential geological disposal of radioactive waste in the layered sequence of fractured volcanic tuffs under Yucca Mountain, Nevada. This is currently being considered by the Nevada Nuclear Waste Storage Investigations Project, administered by the Nevada Operations Office of the US Department of Energy.

32406 **(SAND—86-1028C) Arctic ice: as viewed by the designer of ice penetrators.** Young, C.W. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 3p. (CONF-8606114—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010471.

From Ice penetration technology workshop; Monterey, CA, USA (16 Jun 1986).

Information is presented on arctic ice and the designing of an ice penetrator. (JDB)

32407 **(UCRL—15780) Integrated Design Evaluation Architecture (IDEA) programmer's manual.** Smith, D.M.; Cahenzli-Clements, L.B.; Judy, M.S.; Fronterhouse, D.C. (Titan Systems, Inc., Albuquerque, NM (USA)). 18 Sep 1985. Contract W-7405-ENG-48. 658p. (TAL-R—002). NTIS, PC A99/MF A01; 1; GPO Dep. File Number DE86010567.

This is an introduction to the IDEA Programmer's Manual. This manual contains three types of information about the programming that was done for the routines created for the IDEA programs. The three items are presented in individual appendices. A discussion of the file structure of the files used in the programs is discussed in Appendix A, each individual routine is discussed in Appendix B, and each common deck is discussed in Appendix C.

32408 **(UCRL—15781) Integrated Design Evaluation Architecture (IDEA). User's manual.** Smith, D.M.; Cahenzli-Clements, L.B.; Judy, M.S.; Fronterhouse, D.C. (Titan Systems, Inc., Albuquerque, NM (USA)). 30 Sep 1985. Contract W-7405-ENG-48. 210p. (TAL-R—001). NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86010479.

This manual introduces you to the user-oriented facilities available in IDEA and present examples of how to use them. 204 figs.

32409 **(UCRL—15802) Lattice parameter modeling of stochastic signals: some fundamental concepts.** Parker, S.R. (Stanford Univ., CA (USA). Dept. of Electrical Engineering). [1986]. Contract W-7405-ENG-48. 54p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010552.

The literature on linear estimation of stationary random processes has undergone a vast expansion in the last decade. One of the foremost areas is that of lattice parameter modeling which has been used most successfully for the modeling of speech and various geophysical phenomena. One particular motivation for these new algorithms is the reduction in the number of numerical operations (from order N^3 to order N log N or possibly order N). In addition, these algorithms have provided some important insights into the physics of the process being modeled, and finally many of the algorithms have the potential of direct efficient implementation on VLSI chips. In this report, some of the basic theoretical aspects of lattice parameter theory are presented. As is often the case in an expanding area, the literature is vast and it is difficult to extract the essential ideas from all that is available. It is the purpose of this report to distill the basic concepts of lattice modeling theory and provide the reader with some essential insight and background for approaching the literature which spans a variety of disciplines including time series analysis, signal processing, estimation theory, stochastic signals and processes, speech, geophysical data analysis, to name a few. 21 refs.

4202 Facilities And Equipment

REFER ALSO TO CITATION(S) 31488, 31518, 31886, 32222, 32391, 33214

32410 **(AD-A—164061/4/XAB) Development of a sensitive superconducting accelerometer and gravity gradiometer. Final report, 1 October 1979-30 September 1984.** Fairbank, W.M. (Stanford Univ., CA (USA). Dept. of Physics). Sep 1984. 153p. NTIS, PC A08/MF A01.

The inverse square law of gravitation is known to agree with astronomical data to very high accuracy, but recent theoretical and experimental work indicate that the inverse square law may be violated at distances less than 1000 km. Such a violation would signal the existence of a new force. In order to check the inverse square law, a search was made for a non-Newtonian force in a cylindrical shell. The cylindrical shell has the property that the Newtonian effects nearly cancel so that we are doing nearly null experiment. A superconducting gradiometer was developed to measure the gravitational-force gradients at the center of this cylindrical shell. By measuring both the vertical and horizontal gradients, effects due to imperfections in the cylinder could be eliminated. This report describes the instrument and its performance as well as calculation of the sensitivity of the inverse square law test.

32411 **(AEEW-M—2244) Impact testing of transportation-flasks. A review of the literature.** Neilson, A.J. (UKAEA Atomic Energy Establishment, Winfrith). Jul 1985. 25p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702037.

The literature describing flask testing is reviewed and it is concluded that, even though there are numerous references to instrumented impact testing of flasks, there remains a need for a collection of data from carefully constructed and fully instrumented model tests for thorough validation of analytical tools.

32412 **(AEEW-R—1899) Plutonium active operation of the Winfrith modular containment system.** Sanders, M.J.; Pengelly, M.G.A.; McSherry, K. (UKAEA Atomic Energy Establishment, Winfrith). Jan 1985. 28p. (PCMRP—85-P5). NTIS (US Sales Only), PC A03/MF A01. File Number DE86702039.

Three gloveboxes contaminated with plutonium have been dismantled inside the Winfrith Modular Containment System. This system is a portable, demountable pressurised suit area with its own filters and shower entry tunnel. Details of the operation are given.

32413 **(BDX—613-3426) Sampling manifold for gas analysis. Final report.** Fuller, E.N. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). May 1986. Contract AC04-76DP00613. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010775.

A design concept for a sampling manifold system for gas analysis has been developed and tested. The design provides for elimination of repeated manual cylinder-to-instrument connections and for concurrent testing with multiple instruments without interference or cross-contamination. A prototype manifold incorporating these design features has been built and performance tested. The manifold, while not a complete system, represents a major building block in a complete system. The tests and actual operating experience demonstrate that the approach is a valid one which allows the instruments used in gas analysis to be incorporated into a unified system achieving increased ease of analysis and a substantial reduction in labor.

32414 **(BDX—613-3479) Robotic burnishing system for solid film lubricant coated parts.** Fureigh, M.L. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). May 1986. Contract AC04-76DP00613. 22p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010774.

A robotic burnishing system in the Painting Department reduced the operation average standard hour content by 64% and maintains a good part-to-part quality level for a group of parts coated with solid film lubricant. Required to be safe and simple to operate, the system uses a small PUMA 260 robot to process coated axisymmetrical pieceparts. Special tooling and seven pairs of robotic fingers were designed and built to handle 24 different small pieceparts. Individual robotic programs were created for each part and stored on 5-1/4 in. floppy disks with backup copies in Numerical Control. The operators and the manufacturing department readily accepted the robotic system. Additional part geometries will be developed for robotic processing. 12 figs.

32415 **(CEGB-TPRD/B—0650/N85) Impact of a fully idealised high speed train into a constrained fuel transport flask.** Dowler, H.J. (Central Electricity Generating Board, Berkeley (UK). Berkeley Nuclear Labs.). May 1985. 22p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702038.

The outcome of an accident involving a high speed train, travelling at 125 mph and impacting a stationary irradiated fuel transport flask, is investigated. The case considered is that of a fully constrained flask and the power cars and carriages are fully idealised. A representation of the impact and an estimate of the resulting force-time curve experienced by the fuel flask are given. It is found that the peak force is not increased by the addition of coaches, but the time duration of the impact is lengthened.

32416 **(CONF-860421—38) Potential applications of NbN composites in fusion reactor magnets.** Capone, D.W. II; Gray, K.E.; Kampwirth, R.T.; Ho, H.L. (Argonne National Lab., IL (USA)). Feb 1986. Contract W-31-109-ENG-38. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010500.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Recent projected requirements for large scale fusion reactor magnets call for the development of advanced superconducting materials capable of producing peak magnetic fields in excess of 15 T with current densities in the windings in excess of 2×10^3 A/cm^2. These materials will be exposed to large stresses (up to 500 MPa) and neutron fluences as high as 10^{22} n/cm^2 over the lifetime of the conductor. The demonstrated strain and radiation tolerance of NbN together with excellent superconducting properties make it a promising candidate to be used in a superconducting composite capable of satisfying these requirements. Our program at Argonne is directed towards demonstrating a method of fabrication which is capable of achieving these goals. Tests will be conducted on moderate lengths of NbN superconducting composites to verify the ability to achieve large overall current densities in magnetic fields up to 20 T. High field applications of NbN are also being investigated by groups in Japan and Germany.

32417 **(CONF-860421—44) Simulation of fusion reactor conditions for superconducting magnet materials.** Hahn, P.A.; Hoch, H.; Weber, H.W.; Birtcher, R.C.; Brown, B.S. (Argonne National Lab., Evanston, IL (USA); Atominstitut der Oesterreichischen Universitaeten, Vienna; Los Alamos National Lab., NM (USA)). Mar 1986. Contract W-31-109-ENG-38. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010523.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

We report on a comprehensive study of neutron irradiation induced changes of critical current densities in a variety of NbTi- and some Nb_3Sn-superconductors with Ti-additions as well as of changes in normal state resistivity of the copper stabilizer at 8 T. The samples were irradiated at 5 K and subjected to room temperature annealing cycles after each irradiation step. The results on NbTi show, in general, small degradations of j/sub c/, which do not exceed 20% over the life time fluence at the magnet location. Contrary to the low-field data we find a rather uniform radiation response of different materials at high fields. The results on $(NbTi)_3Sn$ show the usual increase of critical current densities with neutron fluence followed by a sharp decrease of j/sub c/. However, the peak of j/sub c/ is shifted to much lower fluences in the alloyed samples as compared to pure Nb_3Sn. Finally, results on the resistivity change of "magnet" copper are presented which indicate that a considerable increase of resistivity (~60% at 8 T) cannot be avoided under reasonable operating conditions of the magnet.

32418 **(ENEA-RT/ING—82-19) Experimentation with loading and unloading machine prototype (PLUM): tests in sodium, washing and reconditioning.** Caponetti, R.; Diamanti, M.; Pierguidi, A. (ENEA, Bologna (Italy). Dipartimento Reattori Veloci). 1982. 35p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86901376.

This report gives a detailed account of the operative procedures and results of the first cycle of experimentation carried out on the prototype loading and unloading machine (PLUM) with regard to: pre-sodium cleaning treatment; washing disassembly and checking; and reconditioning.

32419 **(FRNC-TH—2230) Study and realization of niobium - amorphous silicon - niobium tunnel junctions.** Khalid, R. (Grenoble-1 Univ., 38 - La Tronche (France)). Jul 1985. 182p. (In French). NTIS (US Sales Only), PC A09/MF A01. File Number DE86752159.

The amorphous silicon deposited by radiofrequency cathode sputtering has been choosed for tunnel barrier. Its high tunnel transparency and its low specific capacity have been evidenced. Sputtered niobium films present good superconducting qualities and give to the Nb-Si-a-Nb sandwich an excellent mechanical behavior. The high level of leakage current and conduction anomalies, systematically observed, have been studied in detail. Results are presented that show a promising future for these junctions.

32420 **(IAEA-SM—286/230P) Testing and evaluation of used UF_6 shipping packages.** Barlow, C.R.; Ziehlke, K.T.; Pryor, W.A.; Housholder, W.R. (Oak Ridge Gaseous Diffusion Plant, TN (USA); Martin Marietta Aerospace, Orlando, FL (USA); USDOE Oak Ridge Operations Office, TN; Nuclear Containers, Inc., Elizabethton, TN (USA)). 1986. Contract AC05-84OT21400. 12p. (CONF-860604—11). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010616.

From International symposium on the packaging and transport of radioactive materials (PATRAM '86); Davos, Switzerland (16 Jun 1986).

Damage to shipping packages and their components, whether due to normal environmental exposure or because of unforeseen accidents, requires occasional reevaluation and requalification to assure the suitability of the packages for continued service. Pressure tests have been conducted on used 30B cylinders that were involved in a warehouse fire to assess the possible damaging effects of the exposure. Deteriorated and mechanically damaged overpacks which had absorbed large quantities of water in service were subjected to drying tests, foam properties were evaluated, and a rehabilitation procedure was developed to allow return of such packages to service. Protective shipping packages show deterioration with extended service, principally structural damage from rough handling and rust damage from exposure to weather and from storage practices which may promote absorption of water by the insulating foam. The structural and thermal properties of the phenolic foam insulation from used shipping packages were found to be not adversely affected by absorbed water, and they were not degraded by the drying process. In order to slow or avoid continuing rust damage in renovated packages, however, a process was developed for drying the foam in commercial facilities prior to restoration work on used or damaged containers. Two 2-1/2-ton steel transport cylinders, type 30B, were involved in a warehouse fire where portions of the cylinders were estimated to have reached a temperature of 1600°F. The cylinders were empty at the time of the fire and thus were not in the protective packages in which full product cylinders are handled while in transit. Hydrostatic burst tests showed that the integrity of the cylinders was not degraded by the fire exposure. They withstood test pressures in excess of 10 times the design pressure, and showed a volume expansion of 30% above the original capacity before rupturing in a completely ductile fashion.

32421 **(K/TS—11780) Magnetic bearings: an adaptive solution to motion-control problems.** Scudiere, M.B.; Gillies, G.T. (Oak Ridge Gaseous Diffusion Plant, TN (USA)). Mar 1986. Contract AC05-84OT21400. 33p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010615.

High-precision rotating machinery often employs sophisticated motion-control systems. Typical of such systems are magnetic bearings. In this paper, the operational principles of feedback systems for magnetically suspended rotors are explored, with special emphasis on the rotor position sensors, servo circuits, and sources of magnetomotive force. Several applications for these systems are identified, and some important design characteristics in magnetic bearing technology are reviewed. The role played by Martin Marietta Energy Systems, Inc., and the University of Virginia in research and development of new suspension/bearing technologies is discussed, and their most recent contributions to this field are presented. 25 refs., 13 figs.

32422 **(LA-UR—86-1249) Fiber optics applications in hostile environments .** Lyons, P.B. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 6p. (CONF-8605110—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010190.

From OPTO '86 conference; Paris, France (13 May 1986).

This Conference focuses on applications of optical fibers in hostile environments. As the introductory paper in this Conference, this communication will trace the evolution of applications of fibers in hostile environments and explore some of the motivations for these applications. A few key examples will be used.

32423 **(LA-UR—86-1298) Analysis of FEL optical systems with grazing incidence mirrors.** Knapp, C.E.; Viswanathan, V.K.; Bender, S.C.; Appert, Q.D.; Lawrence, G.; Barnard, C. (Los Alamos National Lab., NM (USA); Applied Optics Research, Albuquerque, NM (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-860366—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010184.

From SPIE technical symposium on applications of artificial intelligence; Orlando, FL, USA (31 Mar 1986).

The use of grazing incidence optics in resonators alleviates the problem of damage to the optical elements and permits higher powers in cavities of reasonable dimensions for a free electron laser (FEL). The design and manufacture of a grazing incidence beam expander for the Los Alamos FEL mock-up has been completed. In this paper, we describe the analysis of a bare cavity, grazing incidence optical beam expander for an FEL system. Since the existing geometrical and physical optics codes were inadequate for such an analysis, the GLAD code was modified to include global coordinates, exact conic representation, raytracing, and exact aberration features to determine the alignment sensitivities of laser resonators. A resonator cavity has been manufactured and experimentally setup in the Optical Evaluation Laboratory at Los Alamos. Calculated performance is compared with the laboratory measurements obtained so far.

32424 **(LA-UR—86-1490) Measurement of performance limits in cryogenic heat pipes.** Haug, F.; Prenger, F.C.; Chrisman, R.H. (Los Alamos National Lab., NM (USA); Astronautics Technology Center, Madison, WI (USA)). 1986. Contract W-7405-ENG-36. 9p. (CONF-860612—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010208.

From 4. AIAA/ASME thermophysics and heat transfer conference; Boston, MA, USA (2 Jun 1986).

This paper describes the results of an experimental study designed to investigate the fabrication and operation of gravity-assist cryogenic heat pipes. Two heat pipes were built, the first having no formal wick but a roughened internal surface, the second having spiral grooves machined with a specially developed tool. The wall material of the heat pipes was brass and hydrogen was used as the working fluid. The wicked heat pipe became operational over the entire temperature range from the triple-point to the critical point. The performance limitation depended on the operating temperature and the tilt angle. Axial heat flux densities of up to 50W/cm^2 were obtained. 15 refs., 9 figs.

32425 **(RFP—3978) FMS precision machining.** Burnham, M.W. (Rockwell International Corp., Golden, CO (USA). Rocky Flats Plant). 1980. Contract AC04-76DP03533. 24p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010805.

In evaluating the technical obstacles and accuracy limits to producing a Precision Flexible Manufacturing System, a current system is subjected to an error budget analysis. It is noted that to make complex part geometries with tolerances in the lower thousandths range, machining to tenths is required for process control. Actual parts made to tenths are illustrated, along with a discussion of the requirements for automation and for process control.

32426 **(SAND—85-1971C) Cask performance and interface specifications for shipment of US spent light water reactor fuel.** Sanders, T.L.; Allen, G.C.; Wilmot, E.L. (Sandia National Labs., Albuquerque, NM (USA); USDOE, Washington, DC). 1986. Contract AC04-76DP00789. 10p. (CONF-860604—10; IAEA-SM—286-117). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010480.

From International symposium on the packaging and transport of radioactive materials (PATRAM '86); Davos, Switzerland (16 Jun 1986).

Preliminary cask physical performance specifications and interface guidelines have been defined to support the development of a family of casks and transporters for shipments in the United States (US) of spent light water reactor fuel. These shipments will be made from US commercial reactor facilities to high-level waste receiving facilities. The specified hardware consists of both truck and rail/barge casks along with their associated transporters.

32427 **(SAND—86-0022) Tape joint stiffness.** Rechard, R.P. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 46p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010626.

This redport evaluates the stiffness for a standard tape-joint structural connection. This stiffness is frequently necessary when modeling a structure (e.g., a shock model). In general, for a standard cylindrical tape joint, the stiffness is 1.2 times greater in compression and 0.67 smaller in tension than the mating shell material. The stiffness of a special-purpose planar and development cylindrical tape joint is also evaluated. Joint stiffness must usually be determined experimentally because standard connections are difficult and/or time consuming to analyze in depth. However, the simple design of the tape permitted a detailed finite-element analysis. The finite-element results on a developmental joint deviated less than 2% from the experimental values in compression and less than 25% in tension. 13 figs.

32428 **(SAND—86-0365) High velocity electromagnetic particle launcher for aerosol production studies.** Benson, D.A.; Rader, D.J. (Sandia National Labs., Albuquerque, NM (USA)). May 1986. Contract AC04-76DP00789. 48p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010355.

This report describes the development of a new device for study of metal combustion, breakup and production of aerosols in a high velocity environment. Metal wires are heated and electromagnetically launched with this device to produce molten metal droplets moving at velocities ranging up to about Mach 1. Such tests are presently intended to simulate the behavior of metal streamers ejected from a high-explosive detonation. A numerical model of the launcher performance in terms of sample properties, sample geometry and pulser electrical parameters is presented which can be used as a tool for design of specific test conditions. Results from several tests showing the range of sample velocities accessible with this device are described and compared with the model. Photographic measurements showing the behavior of tungsten and zirconium metal droplets are presented. Estimates of the Weber breakup and drag on the droplets, as well as calculations of the droplet trajectories, are described. Such studies may ultimately be useful in assessing environmental hazards in the handling and storage of devices containing metallic plutonium.

32429 **(SAND—86-1027C) Kinematic model of ice penetration with lateral loading.** Young, C.W. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 2p. (CONF-8606114—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010470.

From Ice penetration technology workshop; Monterey, CA, USA (16 Jun 1986).

The proposed analytical model involves a continuous interaction between distributed pressure along the penetrator body and penetrator kinematics. The code is called a Simplified Analytical Model for Penetration with Lateral Loading (SAMPLL). The code was originally developed for rock and concrete penetration and was recently extended to include ice penetration.

32430 (SAND—86-2065C) Modal test structure project status report. Smallwood, D.O.; Gregory, D.L. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 28p. (CONF-8605105—2). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010100.

From 32. annual Institute of Environmental Sciences technical meeting; Dallas, TX, USA (6 May 1986).

The objectives of the study were to develop a simple test structure which could be used to compare modal systems and modal methods. A secondary objective would be to develop a structure which could be used to train newcomers to modal testing. We wanted a structure which would be easy to analyze, have well defined properties, be easy to fabricate, and have both widely spaced and closely coupled modes. The widely spaced modes could test the single degree of freedom methods and the closely coupled modes could test the multiple degree of freedom methods. Most test structures have very low damping, while most real structures have significant damping. Each range of damping presents its own problems for modal extraction. We wanted to find a mateial with a moderate amount of damping to more closely model the kinds of structures frequently tested.

32431 (UCID—19592-Rev.2) DYNA3D user's manual (nonlinear dynamic analysis of structures in three dimensions). Revision 2. Hallquist, J.O.; Benson, D.J. (Lawrence Livermore National Lab., CA (USA)). Mar 1986. Contract W-7405-ENG-48. 138p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86010256.

The user's manual for DYNA3D, an explicit three-dimensional finite element code for analyzing the large deformation dynamic response of inelastic solids and structures is updated. A contact-impact algorithm permit gaps and sliding along material interfaces with friction. By a specialization of this algorithm, such interfaces can be rigidly tied to admit variable zoning without the need of transition regions. Spatial discretization is achieved by the use of 8-node solid elements, 2-node beam elements, 4-node shell elements, 8-node solid shell elements, and rigid bodies. The equations-of-motion are integrated in time by the central difference method. DYNA3D contains sixteen material models and nine equations of state to cover a wide range of material behavior. 40 refs., 43 figs.

32432 (UCID—20727) Fundamentals of thin lens optical systems. Lectures I, II and III. Seppala, L. (Lawrence Livermore National Lab., CA (USA)). 8 Apr 1986. Contract W-7405-ENG-48. 69p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010642.

Viewgraphs are presented on the topics of: the physical properties of a thin lens - principal planes, focal points - and the imaging properties of a thin lens - object and image planes and magnification; the Y-Nu method for tracing paraxial rays through a thin lens optical system; and derivation of some of the fundamental relationships in a thin lens system.

32433 (UCID—20753) 3 ωX fiber optic dispersion and transmission measurements. Thompson, C.E.; Powell, H.T. (Lawrence Livermore National Lab., CA (USA)). 17 Apr 1986. Contract W-7405-ENG-48. 26p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010640.

We have measured the dispersion and transmission of the standard Nova optical fiber used for transporting beam samples to a streak camera and an experimental fiber at 350 nm. These data indicate that the experimental fiber, provided by Bell Laboratories, can be used on Nova for $3\omega_0$ signal transmission at lengths up to 20 m with negligible pulse broadening at 100 ps while the standard Nova fiber contributes approximately 120 ps pulse-broadening (i.e., FWHM = 160 ps). However, the Bell fiber exhibits considerably more attenuation than previously encountered at $3\omega_0$. We are obtaining several hundred meters of the Bell fiber for potential near-term use on Nova and will be testing slightly modified designs which should have less attenuation.

32434 (UCRL—93474) Simple, compact, high brightness source for x-ray lithography and x-ray radiography. Hawryluk, A.M. (Lawrence Livermore National Lab., CA (USA)). 19 Feb 1986. Contract W-7405-ENG-48. 10p. (CONF-8603111—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009723.

From Society of Photo-Optical Instrumentation Engineers conference on electron-beam, X-ray and ion-beam techniques for submicrometer lithographies; Santa Clara, CA, USA (9 Mar 1986).

A simple, compact, high brightness x-ray source has recently been built. This source utilizes a commercially available, cylindrical geometry electron beam evaporator, which has been modified to enhance the thermal cooling to the anode. Cooling is accomplished by using standard, low-conductivity laboratory water, with an inlet pressure of less than 50 psi, and a flow rate of ~0.3 gal/min. The anode is an inverted cone geometry for efficient cooling. The x-ray source has a measured sub-millimeter spot size (FWHM). The anode has been operated at 1 KW e-beam power (10 KV, 100 ma). Higher operating levels will be investigated. A variety of different x-ray lines can be obtained by the simple interchange of anodes of different materials. Typical anodes are made from easily machined metals, or materials which are vacuum deposited onto a copper anode. Typically, a few microns of material is sufficient to stop 10 KV electrons without significantly decreasing the thermal conductivity through the anode. The small size and high brightness of this source make it useful for step and repeat exposures over several square centimeter areas, especially in a research laboratory environment. For an aluminum anode, the estimated Al-K x-ray flux at 10 cms from the source is 70 $\mu W/cm^2$.

32435 Concentric micro-nebulizer for direct sample insertion. Fassel, V.A.; Rice, G.W.; Lawrence, K.E. (to Dept. of Energy, Washington, DC). US Patent 4,575,609. 11 Mar 1986. Filed date 6 Mar 1984. vp.

This patent describes a concentric micro-nebulizer for introducing liquid samples into a plasma established in a plasma torch including a first tube connected to a source of plasma gas. The concentric micro-nebulizer consists of inner and outer concentric tubes extending upwardly within the first tube for connection to a source of nebulizer gas and to a source of liquid solvent and to a source of sample liquid. The inner tube is constructed and arranged for connection to the source of liquid solvent and to the source of sample liquid. The outer tube is constructed and arranged for connection to the source of nebulizer gas, the outer tube having an orifice positioned slightly below the plasma when it is established. The inner and outer tubes form an annulus therebetween with the annular spacing between the tubes at the orifice is less than about 0.05 mm around the entire periphery thereof, the volume of the inner tube between the end thereof near the orifice and the connection thereof to the source of sample liquid is less than about 5 microliters.

32436 Theory of critical currents and perpendicular upper critical fields for superconducting proximity systems. Biagi, K.R. Ames, IA; Iowa State Univ. (1985). 102p. University Microfilms Order No. 85-24,634.Contract W-7405-ENG-82. Thesis (Ph. D.).

This thesis is divided into two sections, each dealing with the response of a superconducting proximity system to an applied magnetic field. In Section I, the maximum supercurrent that can be carried in an applied perpendicular magnetic field by a superconducting normal-metal superconducting (SNS) junction consisting of a square normal-metal layer sandwiched between two crossed perpendicular superconducting strips is investigated theoretically. For weak applied fields, the critical current is suppressed reversibly as induced Meissner screening currents flow into the SNS sandwich and generate a spatially varying magnetic field largely parallel to the junction, thereby altering the local phase difference. For stronger applied fields, the critical current is changed irreversibly as vortices enter and become pinned in the junction. In Section II, Eilenberger's quasi-classical formulation of superconductivity is used to derive an equation for the upper critical field of a multilayered SN system in a perpendicular magnetic field. The alternating layers are coupled via the proximity effect and are in the dirty limit.

32437 (RFP-Trans—461) Flexible fabrication system for crankcase. Rankenhohn, W. Translated from *Werkstatt und Betrieb ;* 116: No. 8, 459-461(1983). Contract AC04-76DP03533. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009676.

Flexibility is the capability of rapidly adapting to situations which vary in behavior and experience. This report presents one

such adaptable system which has been installed by a supplier to the automobile industry in England. This plant produces mainly for the domestic market and had to streamline its fabrication of crankcases.

4203 Lasers

REFER ALSO TO CITATION(S) 32546, 32556, 32648, 33222, 33299

32438 **(AD-A—164071/3/XAB) Advanced design atomic hydrogen maser research and development. Final report, 1 December 1982-31 December 1985.** Peters, H.E. (Sigma Tau Standards Corp., Tuscaloosa, AL (USA)). 31 Dec 1985. 43p. NTIS, PC A03/MF A01.

The objectives of this contract were to develop atomic-hydrogen masers based upon novel concepts of cavity stabilization and new designs of the maser-physics unit to provide improved stability and environmental isolation as well as a reduction in size,, weight, cost, and power consumption. First, new maser designs were developed that implemented electronic cavity frequency stabilization using the cavity frequency switching technique. These new designs also incorporated a novel cavity assembly which is smaller than that used in past masers and new quadrupole-state selectors based upon concepts described in the cited referfences. Then two representative hydrogen masers were constructed and tested and experiments were performed to optimize the electronic systems.

32439 **(AD-A—164115/8/XAB) 14-GHz operation of Q-switched diode lasers.** Tsang, D.Z.; Walpole, J.N.; Groves, S.H. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 1985. 5p. (MS—6647A). NTIS, PC A02/MF A01.

Q-switched diode lasers were operated in a continuous-inversion mode of Q-switching at pulse repetition rates of 14 GHz with a measurement system limited 40 ps FWHM pulse width. In continuous-inversion Q switching, the gain in the amplifier section of the device is continuously high while the laser is modulated by an intracavity electro-absorption modulator. The low capacitance of the modulator section of a Q-switched laser makes it attractive for high-speed modulation, especially when integrated with other electronic devices.

32440 **(AD-A—164116/6/XAB) Room-temperature operation of GaAs/AlGaAs diode lasers fabricated on a monolithic GaAs/Si substrate.** Windhorn, T.H.; Metze, G.M. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). 15 Nov 1985. 4p. (JA—5766). NTIS, PC A02/MF A01.

Room-temperature operation was achieved for GaAs/AlGaAs heterostructure diode lasers fabricated on a monolithic GaAs/Si substrate. These devices, which incorporate a large optical cavity structure grown by molecular beam epitaxy directly on a Si wafer, have exhibited threshold currents as low as 775 mA and power outputs as high as 27 m W/facet in pulsed operation.

32441 **(AD-A—164166/1/XAB) Axial injection TEM orbitron maser. Memorandum report.** Burke, J.M.; Manheimer, W.M. (Naval Research Lab., Washington, DC (USA)). 31 Jan 1986. 58p. (NRL-MR—5675). NTIS, PC A04/MF A01.

The linear theory of the TEM orbitron maser models the interaction of axially injected electrons orbiting the positively charged center conductor of a coaxial waveguide with the TEM waveguide mode. The theory treats electrons with arbitrary values of angular momentum. The threshold values of the cavity Q multiplied by the electron beam power required for self-oscillation in a finite length oscillator configuration is presented as well as the spatial growth rate calculated for an infinite-length TEM orbitron amplifier. The basic design equations for the axial injection scheme are developed.

32442 **(AD-A—164167/9/XAB) Induced-resonance electron-cyclotron (IREC) quasi-optical maser. Memorandum report.** Sprangle, P.; Tang; Serafim, P. (Naval Research Lab., Washington, DC (USA)). 31 Jan 1986. 19p. (NRL-MR—5678). NTIS, PC A02/MF A01.

This paper analyzes an induced-resonance electron-cyclotron (IREC) quasi-optical maser configuration. This configuration has the unique features of being highly efficient and at the same time relatively insensitive to the detrimental effects of poor beam quality. A system of nonlinear coupled-orbit equations, describing the dynamics of electrons in a spatially varying external magnetic field and the electromagnetic field of a steady-state oscillator, are derived and analyzed. We show that with the proper choice for the index of refraction, the high-frequency cyclotron interaction can be made insensitive to a beam energy spread. The interaction can, however, be sensitive to the beam's pitch-angle spread. The necessary conditions on beam quality for high-efficiency operation are derived and shown to be in good agreement with numerical solutions. Furthermore, it is shown that by appropriately tapering the magnetic field an induced resonance condition can be achieved that results in high interaction efficiencies. It is anticipated that an efficient, high power millimeter, submillimeter, and infrared radiation source can be realized with the IREC quasi-optical maser configuration.

32443 **(AD-A—164188/5/XAB) Nonlinear optical techniques for visible and uv lasers and thin film deposition. Final report, 1 October 1984-30 September 1985.** Eden, J.G. (Illinois Univ., Urbana (USA). Dept. of Electrical and Computer Engineering). Nov 1985. 18p. NTIS, PC A02/MF A01.

Thin-metal films were deposited by a multiphoton ionization technique. Laser-initiated semiconductor thin-film growth was demonstrated and laser irradiation of the substrate produced higher-quality films than that obtained by growth without the laser. Also, laser-induced breakdown (LIB) was shown to be a highly sensitive technique for detecting minute impurities. In addition, a significant improvement in XeCl laser energy output was realized by the injection of a low-intensity UV laser pulse into the XeCl laser cavity.

32444 **(AD-A—164192/7/XAB) Storage-ring technology for free-electron lasers. Final technical report, 25 April 1983-24 April 1984.** Madey, J.M.J.; Deacon, D.A.G. (Stanford Univ., CA (USA)). Apr 1984. 198p. NTIS MF A01.

Laser operation was achieved and a series of discoveries on the operational characteristics of storage-ring lasers were made, including self-pulsing and transverse mode coupling. The self pulsing phenomenon was observed to permit the continuous variation of the peak output power of the device. Analysis of the data taken on the optical klystron and the laser-induced bunch lengthening was completed. Contents include: Measurement of stimulated transverse mode mixing in a free electron laser; Transverse Mode dynamics in a free-electron laser; Measurement of the violation of the Madey Theorem induced by a diverging wave; Observation of the diffraction-induced violation of the Madey theorem; Optical klystron experiments for the ACO storage-ring free-electron laser; Characterization of free-electron laser bunch lengthening on the ACO storage ring; Inhomogeneous Broadening calculation with a single integral; and Realization of a variable aperture diaphragm working in ultra high vacuum.

32445 **(AD-A—164273/5/XAB) Cylindrical gaussian-hermite modes in rectangular waveguides resonators. Technical report, 14 January 1981-13 January 1982.** Elias, L.R. (California Univ., Santa Barbara (USA). Quantum Inst.). 1983. 6p. (TR—17). NTIS, PC A02/MF A01.

Approximate solutions to the wave equation inside a rectangular metallic waveguide was obtained in terms of cylindrical Gaussian-Hermite functions. E/sub mn/ modes propagate with negligible straight guide losses in the far-infrared region. A new type of low-loss optical resonator suitable for free electron lasers (FEL) operation at long wavelengths is presented.

32446 **(AD-A—164276/8/XAB) Cylindrical Gaussian eigenmodes of a rectangular waveguide resonator: three-dimensional numerical calculation of gain per mode. Technical report, 1 October 1983-30 September 1984.** (California Univ., Santa Barbara (USA). Quantum Inst.). 1984. 13p. (TR—24,). NTIS, PC A02/MF A01.

First we present approximate analytical solutions to the wave equation inside an over-moded metallic retangular waveguide. The cold eigenmodes are expressed in terms of cylindrical Gaussian-Hermite functions times trigonometric functions to insure the

boundary conditions. A numerical three-dimensional calculation for a free electron laser (FEL) amplifier is discussed, which is based on the Lienard-Wiechert solution of the Maxwell's equations cast in an integral form. This approach is readily and efficiently extended to include the effects of the metallic boundaries of the waveguide by means of the method of image currents. Finally, the radiation field in the cavity emitted by the electrons in the presence of the combined fields of a co-propagating eigenmode wave plus a linearly polarized magnetic undulator is expanded in terms of cavity eigenmodes. This expansion allows the gain per resonator mode to be computed.

32447 **(AD-A—164309/7/XAB) Laser-feedbackccontrol design for passive-ring-laser gyros in a very-high-finesse cavity. Master's thesis.** Lorenz, M.A. (Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering). Dec 1985. 114p. NTIS, PC A06/MF A01.

The Frank J. Seiler Research Laboratory is currently developing a passive resonant ring laser gyroscope (PRRLG) enclosing 58 sq m for proposed use in testing high precision rate sensors and for possibly validating the theory of general relativity. The sensitivities required for such experiments are in the 10^{-7} to 10^{-10} Earth Rate Unit (ERU) range. This high sensitivity necessitates the use of a large, high finesse cavity. In dealing with high finesse cavities new considerations arise. For example, the cavity linewidth is narrower than linewidths of commercially available stabilized He-Ne lasers. The stability of the laser then becomes the limiting factor in the performance of the PRRLG because of the increased signal-to-noise ratio that arises in this situation. In addition, high-finesse cavities exhibit photon lifetimes on the order of 10^{-3} to 10^{-6} seconds, which limits the bandwidth of practical controllers. In this research, a PRRLG was constructed in which a He-Ne laser was frequency locked to 25,000 finesse, 169 sq. cm. resonant cavity, as opposed to the more-traditional technique of locking the resonant condition of the cavity to the laser frequency.

32448 **(AD-A—164524/1/XAB) Direct modulation and active mode locking of ultrahigh-speed GaAlAs lasers at frequencies up to 18 GHz.** Lau, K.Y.; Yariv, A. (California Inst. of Tech., Pasadena (USA). Dept. of Applied Physics). 15 Feb 1985. 4p. NTIS, PC A02/MF A01.

It is demonstrate that an ultrahigh speed window buried heterostucture GaAlAs laser fabricated on a semi-insulating substrate can be used as a narrowband signal transmitter in the Ku band frequency range (12-20 GHz). The modulation efficiency can be increased over a limited bandwidth by a weak optical feedback. A stronger optical feedback enables one to actively mode lock the laser diode at a very high repetition rate up to 17.5 GHz, producing pulses approx. 12 ps long.

32449 **(BDX—613-3425) YAG laser monitoring. Final report.** Wonnell, L.D. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). Apr 1986. Contract AC04-76DP00613. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010301.

A program has been initiated to characterize, calibrate, and monitor the output of high power Nd:YAG lasers at Allied Corporation, Bendix Kansas City Division (BKC). This program was developed to aid in maintaining product quality in the application of these lasers during manufacturing processes. Reference standards have been established, a basic calibration procedure outlined, critical laser output parameters identified, and recommendations made on instrumentation for in-process monitoring of Nd:YAG lasers. Success was related to the design and construction of two major items, a reference sensor assembly for characterizing and calibrating the direct output of a laser and a laser output monitor for continuous monitoring of a laser's output. 16 figs.

32450 **(CONF-860316—7) Possibility of obtaining coherent short wave radiation from a solid state free electron laser.** Bogacz, S.A.; Ketterson, J.B. (Northwestern Univ., Evanston, IL (USA). Dept. of Physics and Astronomy; Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010525.

From Topical meeting on short wavelength coherent radiation; Monterey, CA, USA (24 Mar 1986).

The idea of using a crystal lattice or a superlattice as an undulator for a free electron laser is explored. A purely classical treatment of relativistic positrons channeling through the proposed structure involving a self consistent solution of the wave equation for the radiating electromagnetic field and the kinetic equation for the positron distribution function leads to a positive gain coefficient for a forward radiating field. Matching the Kumakhov resonance to the undulator frequency further enhances the gain. This result, combined with a feedback mechanism arising from Bragg diffraction within the basic crystal lattice, leads to an instability of the radiation inside the crystal. Finally a numerical estimate of the Kumakhov-enhanced gain coefficient is made for the (110) planar channeling in a strain modulated Si superlattice. 8 refs., 4 figs.

32451 **(FRNC-TH—2229) Transport parameter calculation in helium and helium-cadmium mixtures. Self consistent determination of the space charge field in the cathode region of a glow discharge.** Dupouy, D. (Toulouse-3 Univ., 31 (France)). Oct 1985. 153p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE86752158.

In this work, we have firstly done a very exhaustive bibliography upon hollow cathode and positive column helium-cadmium lasers. Considering the case where electrons are in equilibrium with the electric field, we have then calculated some macroscopic parameters (ionization coefficients, drift velocity,...) in helium and helium-cadmium mixtures. These results have been used to simulate, via the macroscopic equations only, the cathodic part of a glow discharge. Finally, we have developed a new formulation which, contrary to the former macroscopic treatment, allows to account for the electrons non-equilibrium effects upon the behaviour of the resulting space-charge field.

32452 (LBL—19100, pp 58-60) **Partially coherent radiation.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

The critical barrier to scientific exploitation of the XUV spectral region is the lack of radiation sources analogous to the intense lasers available in the visible and infrared. Undulators, operating in a storage ring of advanced design, are a first step toward filling this need, but we are looking even beyond these yet-to-be-realized sources. In particular, we are studying transverse optical klystrons and free-electron lasers, as well as the low-emittance ring designs that would be necessary to make them practical tools.

32453 **(UCRL—15804) Studies on production of metastable core-excited atoms by laser-produced x-rays. Final report, 1 October 1984-30 September 1985.** Harris, S.E.; Young, J.F. (Stanford Univ., CA (USA). Edward L. Ginzton Lab.). Apr 1986. Contract W-7405-ENG-48. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010562.

The overall objective of the work on this program was to study methods for production of core-excited metastable atoms by laser-generated x-rays. We are interested in the spectroscopy of these levels, their autoionizing and radiative rates, and their metastability in the presence of hot electrons and ions. The concept of using x-rays emitted from a laser-produced plasma to excite large densities of energetic excited levels in atoms and ions has been thoroughly experimentally investigated using modest, 100 mJ, plasma-producing lasers. One of the objectives of this work was to verify that these techniques could be scaled up to higher energies, such as 20 J. Thus a major effort this year has been devoted to the design and construction of the high energy (20 J) 1064 nm plasma-forming laser system and the tunable probe/transfer laser.

32454 **(UCRL—94454) Multi-megajoule Nd: glass fusion laser design.** Manes, K.R. (Lawrence Livermore National Lab., CA (USA)). 4 Apr 1986. Contract W-7405-ENG-48. 35p. (CONF-851053—14). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010559.

From 7. international workshop on laser interaction and related plasma phenomena; Monterey, CA, USA (28 Oct 1985).

New technologies make multi-megajoule glass lasers economically feasible. Laser architectures using harmonic switchout,

target plane holographic injection, phase conjugation, continuous apodization and higher amplifier efficiencies have been devised. A plan for a multi-megajoule laser which can be built for an acceptable cost relies on manufacturing economies of scale and the demonstration of the new technologies presented here. These include continuous pour glass production, rapid harmonic crystal growth, switching of large blocks of power using larger capcaitors packed more economically and by using large identical parts counts.

32455 **Interelement coupling in gain-guided diode laser arrays.** Hohimer, J.P.; Hadley, G.R.; Owyoung, A. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Applied Physics Letters;* **48**: No. 22, 1504-1506(2 Jun 1986). Contract AC04-76DP00789.

Below-threshold studies of an injection-locked gain-guided diode laser array show a far-field emission pattern with several lobes whose angular widths decrease with increasing frequency of the injected radiation. The concurrent increase in the far-field emission angle with the frequency of the injected radiation provides strong evidence that the interelement coupling in a gain-guided diode laser array depends upon the tilt of the wave front in the array cavity. These results provide insight into the coupling mechanism that dominates gain-guided array behavior and strongly suggest that these devices should be viewed as perturbed broad-area devices in which plane waves are undergoing multiple reflections between facets. This contrasts sharply with the coupled-mode picture, which is more appropriate for index-guided arrays.

32456 **Model for electron cooling by radiation losses in plasmas: Application to development of soft x-ray lasers.** Skinner, C.H.; Keane, C. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Applied Physics Letters;* **48**: No. 20, 1334-1336(19 May 1986).

We present a simple model which may be used to evaluate the suitability of different ions for rapid plasma cooling by line radiation in recombination pumped x-ray laser schemes.

32457 **Injection locking of diode lasers.** Hadley, G.R. (Sandia National Labs., Albuquerque, NM). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **QE-22**: No. 3, vp(Mar 1986). Contract AC04-76DP00789.

The authors present a theoretical analysis of the forward and reflected amplitudes in a diode laser oscillator cavity for both a single resonant mode and an injected signal. The analysis includes gain saturation and allows the gain coefficient at the injected frequency to be different from that at the resonant frequency. Analytic solutions for the axially dependent amplitudes are presented for the case of equal gain coefficients. For the more general case, a formula is presented for the intensity necessary for locking, which is shown to reduce in various limits to other expressions previously published. One immediate consequence of the present formalism is that the use of antireflection coatings on the diode end facets should act to reduce the injected signal intensity necessary for locking. In fact, reduction of the reflectivities to values of a few percent should enable locking over the entire gain curve with incident intensities which are small compared to the slave oscillator's normal output.

32458 **Measurement of gain in an optically-excited mixture of D2 and Ar at high density.** Mcleary, R. (Defence Science and Technology Organization, Melbourne, Australia). *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics;* **QE-21**: 336-340(Apr 1985).

Collision-induced gain of approximately 0.015/cm at a wavelength near 4 microns has been measured in a high-density mixture of D2 and Ar. The D2 molecules were excited by collision-induced absorption of radiation from a hydrogen-fluoride laser. 14 references.

32459 **Chemical flashlamp pumping of Nd:glass.** Gavenonis, T.L.; Hewitt, W.H.; Kling, M.R.; Shaffer, J.W.; Waymouth, J.F. (GTE Products Corp., Montoursville, PA). pp 135 of 18th Middle Atlantic Regional Meeting, American Chemical Society. Newark, NJ; New Jersey Institute of Technology (1985). (CONF-8405347—).

From 18. American Chemical Society Middle Atlantic Regional meeting; Newark, NJ, USA (21 May 1984).

Chemical flashlamps have been investigated as a possible alternative for electrically driven flashlamps for pumping Nd:glass fusion lasers. The motivation was a potential cost savings since very large fusion lasers will be used for relatively few shots (~ 1000). The following flash parameters were assumed necessary: (1) time to peak output of less than one msec., and (2) radiant output greater than 80J per cm^3 of flashlamp volume. For reference, the commercial Flash Bar produces 300 J/cm^3 with a peak time of 20 msec. Peak times as short as 1 msec. have been claimed by Brecher using yttrium-fluorine reactions accelerated by halocarbons. Using capacitive discharge ignition, peak times as short as 0.2 msec. have been presently obtained. Various metal (Y, Zr, Hf, Mg)-oxidizer (O_2, F_2, OF_2, ClF, ClF_3, ClO_3F) combinations were tested. The best overall properties for Nd:glass pumping were obtained with $Zr\text{-}OF_2$ filled lamps. Unfortunately, the output energy requirement has not been achieved in short pulses.

32460 **(LA-tr—86-22) First free-electron laser in China went in operation.** Ch'u, C.; Lu, T.; Shih, J. Translated from *Zhongguo Jiguang ;* **12**: No. 12, 767(1985). Contract W-7405-ENG-36. 3p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010771.

The paper reports experimental results on radiation output of China's first free electron laser based on the principle of stimulated Raman scattering.

32461 **XUV/VUV free-electron laser oscillator.** Goldstein, J.C.; Newnam, B.E.; Cooper, R.K.; Comly, J.C.,JR. (Los Alamos National Lab., NM). pp 293-303 of Laser techniques in the extreme ultraviolet; Proceedings of the second topical meeting, Boulder, CO, March 5-7, 1984. Harris, S.E.; Lucatorto, T.B. New York, NY; American Institute of Physics (1984). (CONF-840387—).

From 2. topical meeting on laser techniques in the extreme ultraviolet; Boulder, CO, USA (5 Mar 1984).

Problems regarding the extension of free-electron laser technology from the visible and near infrared region, where such devices are currently operating, to the ultraviolet have recently been extensively discussed. It was found that significant technical problems must be overcome before free-electron lasers (FELs) can be operated in the VUV (100-200 nm) and the XUV (50-100). However, the present lack of other intense and tunable sources of coherent radiation at these wavelengths together with the intrinsic properties of FELs make the development of such devices potentially very rewarding. The properties of FELs include continuous tunability in wavelength and output in the form of a train of picosecond pulses. An investigation is conducted regarding the feasibility of an operation of a FEL in the XUV/VUV regions, taking into account a theoretical model. It is found that modest improvements in electron beam and optical mirror technologies will make the design of a FEL for operation in the 50-200-nm range of optical wavelength possible. 10 references.

4204 Heat Transfer And Fluid Flow

REFER ALSO TO CITATION(S) 31788, 31808, 31841, 31898, 31899, 31908, 31944, 31946, 31947, 31950, 32068, 32092, 32424

32462 **(AD-A—164070/5/XAB) Research on turbine flowfield analysis methods. Final report, 1 April 1983-30 November 1984.** Rae, W.J. (Arvin Calspan, Buffalo, NY (USA). Applied Technology Group). Jan 1985. 112p. (CALSPAN—7177-A-3). NTIS, PC A06/MF A01.

This report contains a description of conformal-mapping procedures that can be used to generate computational grids for turbomachinery flowfield calculations, and to determine the incompressible potential flow on such a grid. The mapping procedures represent an extension of the Ives transformation to blade rows having a high solidity. The flowfield solution takes advantage of the fact that one of the mapping steps takes the blade row into a unit circle; by writing down the classical source/sink/vortex solution in this circle, it is possible to find the incompressible potential flow in the original cascade. This solution is of interest in its own

right, and provides a useful initial condition for iterative or time-marching calculational method.

32463 **(AECL—8180) Computation of two-dimensional isothermal flow in shell-and-tube heat exchangers.** Carlucci, L.N.; Galpin, P.F.; Brown, J.D.; Frisina, V. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Jul 1983. 22p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901068.

A computational procedure is outlined whereby two-dimensional isothermal shell-side flow distributions can be calculated for tube bundles having arbitrary boundaries and flow blocking devices, such as sealing strips, defined in arbitrary locations. The procedure is described in some detail and several computed results are presented to illustrate the robustness and generality of the method. 11 figs.

32464 **(CEA-R—5323) Measurement of void fraction disturbances in a two-phase flow in a pipe of circular cross-section with impedance probes.** Tournaire, A. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Inst. de Recherche Technologique et de Developpement Industriel (IRDI)). Nov 1985. 54p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751812.

In a vertical pipe of circular cross-section the instantaneous response of an impedance probe which has its electrodes mounted flush in the tube wall to avoid disturbing the two-phase flow, depends on the void fraction distribution. Different probe geometries (different widths and numbers of electrodes) and different AC supplies were studied to minimize the influence of this parameter. With single phase AC supply the electrodes of intermediate width yield the best results. An increase from two to four electrodes, does not entail any improvement whatever the kind of electrode connection. With a six-phase AC supply, such that a rotating electric fields is obtained within six electrodes, the results are better than those obtained with two electrodes of intermediate width supplied with single phase current. 7 refs.

32465 **(DOE/ER/13239—1) Air flow inside a pneumatic tire. Final report.** Rae, W.J. (State Univ. of New York, Buffalo (USA). Dept. of Mechanical and Aerospace Engineering). Aug 1985. Contract FG02-84ER13239. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007850.

This document contains a final report on all technical activity on Contract No. DE-FG02-84ER13239. This work involved a one-year theoretical study of the airflow that takes place inside a rolling pneumatic tire. Analytical and numerical studies of the flow are reported, which show details of the velocity, pressure and temperature fields that are generated at low forward speed. These results are found to be consistent with velocity-field measurements taken under a previous Department of Energy study. 9 figs.

32466 **(DOE/MC/20334—T30) Study of deposition control using transpiration. Technical progress report.** Louis, J.F.; Kozlu, H. (Massachusetts Inst. of Tech., Cambridge (USA)). Apr 1986. Contract AC21-83MC20334. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010408.

The purpose of this project is to determine the conditions under which transpiration may be actually used to avoid deposition of small particles. The application of this work is the control of the deposition of small particles over a surface kept at a temperature below the melting point of compounds likely to exist in the combustion products. A combined experimental and theoretical research program will be carried out to evaluate the concept of transpiration as a deposition control strategy. A first order theory will be refined by introducing an appropriate turbulence model. The experimental program is designed to evaluate and refine the theoretical model under conditions which provide the correct Reynolds and Stokes numbers. The experimental set up consists of a wind tunnel with a test section containing a flat porous transpired section. The measurements will determine the distribution of velocity and of particle concentration in the boundary layer. The experiments will be conducted for different particle sizes under conditions simulating gas turbine conditions. The classification of coal particles has run into some difficulties due to technical problems associated with the ATP 50 classifier of Alpine American Corporation and the agglomeration of the coal particles. Alpine American Corporation has made available their ATP 50 classifier and a sample run has been made. We observe strong agglomeration of the coal particles as was indicated by the Mikropul Corporation in their classification. However, besides agglomeration the results of the classification are also unsatisfactory. Our analysis and search showed that the classification of coal particles is an extremely difficult process.

32467 **(LCC—021/85) Modelling of the filling up of a porous plate.** Sampaio, R.; Gama, R.M.S. da. (Laboratorio de Computacao Cientifica, Rio de Janeiro (Brazil)). 1985. 7p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702033.

A generalization of Darcy's law is constructed using Mixture Theory to describe the transient flow of an incompressible fluid through a rigid solid porous matrix. The model is used to study the process of filling-up of an one dimensional unsaturated porous medium that is mathematically described by a system of nonlinear hyperbolic equations which is nonhomogeneous due to the drag force between the fluid and the solid matrix. The system is analysed throughly and solved numerically using the Glimm-Chorin method with a splitting to treat the non-homogeneous term. The results are discussed and shown to describe well the filling-up process.

32468 **(LCC—022/85) General variational formulation for problems of heat transfer by diffuse radiation.** Gama, R.M.S. da. (Laboratorio de Computacao Cientifica, Rio de Janeiro (Brazil)). 1985. 19p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702034.

A variational principle is shown which is suitable for the solution of any problems involving heat interchange by diffuse radiation in nonparticipating media. The basic radiation theory is briefly discussed, with the deduction of the system of integral equations that governs the phenomenon in the general case where the temperature is variable according to the position, as well as the emittance and the reflectance which also depend on the radiation wavelength. It will be shown that the equation system can always be represented by a Fredholm integral equation of the second kind. Several particular cases are shown with the suitable simplifications.

32469 **(LCC—023/85) Constitutive relations for flow of a non-newtonian fluid through saturated porous media.** Gama, R.M.S. da; Sampaio, R. (Laboratorio de Computacao Cientifica, Rio de Janeiro (Brazil)). 1985. 16p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702035.

The behavior of two types of non-newtonian incompressible fluids, flowing through a porous medium which is assumed to be composed by several plane plates separated by a constant distance, is analysed. With the obtained results, constitutive relations are proposed for calculating the solid-fluid interaction force, that appears in the equations of the Continuum Theory of Mixtures, when the fluid and the solid (porous medium) are assumed continuous constituents of a binary mixture.

32470 **(NAA-SR—8026) Conductive heat transfer with a radiation boundary condition.** Gresho, P.M. (Atomics International, Canoga Park, CA (USA)). 10 Dec 1962. 16p. North American Aviation, Inc., Downey, CA. File Number TI86901304.

A fairly common problem in heat transfer is determining the effect of conductive insulators in a system where radiation is the principal mode of energy transport. This report presents working curves for such calculations as well as a means for comparison of conductive insulation to insulation via several theoretical radiation shields of equal emissivities. The curves shown are general for any geometry, the only assumptions being one-dimensional heat conduction and constant thermal conductivity.

32471 **(NP—6752025) Experimental investigation on transient turbulent friction behaviour of superposed pressure pulse in a circular pipe.** Arlt, H. (Technische Univ. Berlin (Germany, F.R.). Inst. fuer Wasserbau und Wasserwirtschaft). 1983. 147p. (In German). NTIS (US Sales Only), PC A07/MF A01. File Number DE86752025.

In the general case of turbulent irregular flow changes there are no reliable date available about the transient friction part. Continuing the experimental investigation of transient wall friction, this paper examines transient pressure changes and this is shown relative to parameters comparable to those of oscillating flow. The experimental plant consists of an 80 m long pipe with a internal diameter of 0.092 m filled with water. In order to keep the effect of pressure variations small, the transient pressure changes are superimposed as pressure pulses on the liquid at rest. The rise time and pressure maxima are variable within wide limits. A range of 747<DV(1/(ν . tsub(A)))<1830 is examined for the frequency parameter and a range of <0.6.10^5<ssub(o) . D/(ν . tsub(A))<9.8.10^5 for the Reynolds number. The extreme experimental conditions create very great requirements for the measuring and assessment techniques, and cannot be achieved without using a process computer and electronic data processing. The transient friction, which causes the deformation of the pressure wave produced, can be read off from the comparison of the pressure wave graph at the beginning and end of the experimental section. In order to make the deviations clear, both graphs are relative to the same origin. Compared with calculations with quasi-stationary or laminar stationary friction, the measurements show significant deviations over wide ranges. The effect of transient friction is shown as a function of rise time and pressure maximum with the time displacement of the pressure maxima. (orig./GL).

32472 **(SERI/TP—252-2847) Blockage of natural convection boundary layer flow in a multizone enclosure.** Scott, D.; Anderson, R.; Figliola, R.S. (Clemson Univ., SC (USA). Dept. of Mechanical Engineering; Solar Energy Research Inst., Golden, CO (USA)). Feb 1986. Contract AC02-83CH10093. 9p. (CONF-860612—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86004430.

From 4. AIAA/ASME thermophysics and heat transfer conference; Boston, MA, USA (2 Jun 1986).

This paper reports the results of an experimental study that examines the transition between flow regimes, as a function of aperture size, in a two-zone enclosure with heated and cooled end walls. A constant heat flux boundary condition was maintained on one vertical end wall, and an isothermal cold temperature sink was maintained on the opposite vertical end wall. All of the remaining surfaces were highly insulated. The transition between the boundary layer driven regime and the bulk density driven regime was established as a function of the geometry of the aperture in the partition that separated the hot and cold zones. The results demonstrate that transition from the boundary layer driven regime to the bulk density driven regime is caused by blockage of the boundary layer flow, when the area of the flow aperture is reduced below a critical value. A simple flow model has been developed which predicts that the critical aperture area for the onset of flow blockage is directly proportional to the number of active heat transfer surfaces and inversely proportional to the Rayleigh number which characterizes the level of heating and cooling provided to the active heat transfer surfaces.

32473 **(UCRL—53669) Errors for calculations of strong shocks using an artificial viscosity and an artificial heat flux.** Noh, W.F. (Lawrence Livermore National Lab., CA (USA)). Dec 1985. Contract W-7405-ENG-48. 68p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86010230.

The artificial viscosity (Q) method of von Neumann-Richtmyer is a tremendously useful numerical technique for following shocks wherever and whenever they appear in the flow. We show that is must be used with some caution, however, as serious Q-induced errors (on the order of 100%) can occur in some strong shock calculations. Three types of Q errors are investigated: (1) Excess Q heating, of which there are two types: (a) excess Wall Heating on shock formation and (b) Shockless Q Heating; (2) Q errors when shocks are propagated over a non-uniform mesh; and (3) Q error in propagating shocks in spherical geometry. As a basis of comparison the Lagrangian formulation of von Neumann-Richtmyer with Q = C_0^2 rho l^2(u/sub x/)^2 is used as the standard. Comparisons are made with other formulations. 9 refs., 30 figs.

32474 **(UCRL—93788) Monte Carlo simulation of free jet flow from a slit.** Anderson, J.B.; Foch, J.D.; Shaw, M.J.; Stern, R.C.; Wu, B.J. (Lawrence Livermore National Lab., CA (USA); Pennsylvania State Univ., University Park (USA). Dept. of Chemistry). Sep 1985. Contract W-7405-ENG-48. 24p. (CONF-860636—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86006705.

From 15. international symposium on rarefied gas dynamics; Grado, Italy (16 Jun 1986).

The expansion of a free jet from a slit source into a vacuum has been simulated using the Monte Carlo procedures developed by Bird. The calculations were made for hard-sphere molecules (γ = 5/3) at several densities to examine the departures from translational equilibrium in the flow field. Results are compared with the predictions of a method-of-characteristics calculation for continuum inviscid flow. The variations of the three components of the kinetic temperature are similar to those of a cylindrical source expansion. Molecular velocities perpendicular to the flow are found to depart from Maxwellian distributions at large distances from the slit. 11 refs., 11 figs.

4205 Materials Testing

REFER ALSO TO CITATION(S) 31795, 31873, 31891, 32176, 32200, 32252, 33223

32475 **(BDX—613-3475) Characterization of radio frequency HMC manufacturing processes. Final report.** Buckholz, K.A.; Taylor, J.L. (Allied Corp., Kansas City, MO (USA). Bendix Kansas City Div.). Apr 1986. Contract AC04-76DP00613. 27p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010300.

A nondestructive inspection method for screening alumina substrates for proper values of dielectric constant and loss tangent was investigated. The method involves measuring the characteristics of a microstrip filter made with the substrate on a screening fixture. Acceptable accuracy was achieved when a relative determination approach to finding the dielectric constant was used; however, use of the screening fixture to test for values of loss tangent requires further study. 9 refs.

32476 **(CONF-860413—2) Needs assessment for nondestructive testing and materials characterization for improved reliability in structural ceramics for heat engines.** Johnson, D.R.; McClung, R.W.; Janney, M.A.; Hanusiak, W.M. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010039.

From 2. international symposium on ceramic materials and components for engines; Luebeck-Travemuende, F.R. Germany (14 Apr 1986).

A general ceramic processing flowsheet and inspections at each stage of the flowsheet are shown. The inspections shown identified as potentially important from the point of view of the development of highly reliable ceramics. The inspections shown were all considered in the assessment of the relative priorities for development of inspection techniques. It is anticipated that a limited number of key inspections will be identified for any given product line. This paper reviews the status and needs for inspections in raw materials, green bodies, and dense ceramics.

32477 **Finite element analysis of the diamond anvil cell: Achieving 4.6 Mbar.** Moss, W.C.; Hallquist, J.O.; Reichlin, R.; Goettel, K.A.; Martin, S. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550). *Applied Physics Letters;* **48**: No. 19, 1258-1260(12 May 1986). Contract W-7405-ENG-48.

We have performed a comprehensive finite element analysis of the diamond anvil cell. Our analysis shows how beveled diamonds and material properties of the gasket affect diamond anvil cell performance. Using the results of the analysis, we have achieved 4.6 Mbar experimentally, which is the highest static pressure reported to date. Possible methods to increase the pressure further are discussed.

4206 Safety Engineering

32478 (CONF-8510118—, pp 2-5) **Overview of Department of Energy programs.** Hill, J.R. (Dept. of Energy, Washington, DC). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

An overview is presented of policies and standards of the US DOE in the protection of the public, government employees, and government property from damage caused by natural phenomena. Included are Department of Energy orders covering policy and standards for natural phenomena hazards mitigation and Office of Nuclear Safety projects related to natural phenomena hazards mitigation. National Federal programs, committees, and reports are listed. 18 references.

32479 (CONF-8510118—, pp 6-12) **Natural phenomena hazards project for Department of Energy sites.** Coats, D.W. (Lawrence Livermore National Lab., CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557. Contract W-7405-ENG-48.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Lawrence Livermore National Laboratory (LLNL) has developed seismic and wind hazard models for the Office of Nuclear Safety (ONS), Department of Energy (DOE). The work is part of a three-phase effort aimed at establishing uniform building design criteria for seismic and wind hazards at DOE sites throughout the United States. In Phase 1, LLNL gathered information on the sites and their critical facilities, including nuclear reactors, fuel-reprocessing plants, high-level waste storage and treatment facilities, and special nuclear material facilities. In Phase 2, development of seismic and wind hazard models, was initiated. These hazard models express the annual probability that the site will experience an earthquake or wind speed greater than some specified magnitude. In the final phase, it is anticipated that the DOE will use the hazard models to establish uniform criteria for the design and evaluation of critical facilities. 13 references, 2 figures, 1 table.

32480 (CONF-8510118—, pp 13-15) **Seismic Safety Guide.** Eagling, D.G. (Lawrence Berkeley Lab., CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The Seismic Safety Guide provides facilities managers with practical guidelines for administering a comprehensive earthquake safety program. Most facilities managers, unfamiliar with earthquake engineering, tend to look for answers in techniques more sophisticated than required to solve the actual problems in earthquake safety. Often the approach to solutions to these problems is so academic, legalistic, and financially overwhelming that mitigation of actual seismic hazards simply does not get done in a timely, cost-effective way. The objective of the Guide is to provide practical advice about earthquake safety so that managers and engineers can get the job done without falling into common pitfalls, prolonged diagnosis, and unnecessary costs. It is comprehensive with respect to earthquakes in that it covers the most important aspects of natural hazards, site planning, rehabilitation of existing buildings, design of new facilities, operational safety, emergency planning, non-structural elements, life lines, and risk management. 5 references.

32481 (CONF-8510118—, pp 16-18) **Maintaining Department of Energy facilities general design criteria.** Metzler, J.F. (Dept. of Energy, Washington, DC). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

A General Design Criteria (GDC) Planning Board has been established in the Department of Energy to streamline the improvement and maintenance of the GDC Manual. This Planning Board, composed of a membership from field organizations and Headquarters programmatic offices, started work on 15 enhancements to the GDC Manual. One of those enhancements details natural phenomena hazards criteria. In the past year the Planning Board submitted a major recommendation which has been implemented into what is known as the GDC Improvements project. The result of this project pledges to dramatically increase the GDC Manual's utilization and effectiveness.

32482 (CONF-8510118—, pp 20-32) **History and role of the International Conference of Building Officials.** Bihr, J.E. (International Conference of Building Officials, Whittler, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

A historical perspective on the International Conference of Building Officials is presented. A primary focus is the development of the Uniform Building Code as the first performance-oriented model building code. Current code development processes are addressed, and an explanation of ICBO services is given with emphasis on code interpretations and application, product evaluation, building department administration and training and education. 12 references.

32483 (CONF-8510118—, pp 33-38) **Codes, standards, and requirements for DOE facilities: natural phenomena design.** Webb, A.B. (Westinghouse Hanford Co., Richland, WA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The basic requirements for codes, standards, and requirements are found in DOE Orders 5480.1A, 5480.4, and 6430.1. The type of DOE facility to be built and the hazards which it presents will determine the criteria to be applied for natural phenomena design. Mandatory criteria are established in the DOE orders for certain designs but more often recommended guidance is given. National codes and standards form a great body of experience from which the project engineer may draw. Examples of three kinds of facilities and the applicable codes and standards are discussed. The safety program planning approach to project management used at Westinghouse Hanford is outlined. 5 figures, 2 tables.

32484 (CONF-8510118—, pp 39-48) **Proposed changes to the seismic design provisions of the Uniform Building Code.** Messinger, D.L. (David L. Messinger, & Associates, Oakland, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

All non-critical DOE facilities are required by DOE 6430.1 to be designed to the seismic provisions of the Uniform Building Code (UBC). This paper will present the current efforts of the Structural Engineer's Association of California (SEAOC) Seismology Committee to re-write their Recommended Lateral Force Requirements and Commentary, the Blue Book. The Blue Book is the basis of the seismic code provisions of the UBC. It is the expressed goal of SEAOC to submit the re-written Blue Book provisions to the International Conference of Building Officials (ICBO) as a code change to the 1985 UBC. ATC-3-06, Tentative Provisions for the Development of Seismic Regulations for Buildings, published by the Applied Technology Council (ATC), is a resource document whose purpose is to present in one comprehensive document the state-of-the-art in the fields of engineering seismology and seismic engineering as it pertains to the seismic design and construction of buildings. The SEAOC Seismology Committee has been working on the revisions to the Blue Book since 1980, and at the start of this effort made a basic decision to follow a modified ATC-3-06 format. The ATC-3-06 format was chosen because it is more consistent as a design procedure with the more rigorous procedures used for the analysis of structures subjected to earthquake motions. This paper will compare the requirements of the 1982 UBC, ATC-3-06, and the proposed Blue Book as to philosophical and technical differences. 5 references.

32485 (CONF-8510118—, pp 49-53) **Development of new codes for seismic design criteria.** Freeman, S.A. (Wiss, Janney, Elstner Associates, Inc., Emeryville, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

A seismic design manual, which provides dynamic analysis procedures that consider two levels of earthquake ground motion, has recently been completed and will soon be published by the US Government Printing Office. The manual, Seismic Design Guidelines for Essential Buildings, is a supplement to the February 1982 edition of Seismic Design for Buildings. The new seismic design guidelines provide an alternative to equivalent static force criteria prescribed in earthquake design requirements of current building codes. 8 references, 2 figures, 1 table.

32486 (CONF-8510118—, pp 56-58) **Natural phenomena design for safety.** Schade, A.R. (Hanford Engineering Development Lab., Richland, WA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Facilities designed and operated by the Westinghouse Hanford Company (WHC) at the Hanford Site are designed/evaluated for the natural phenomenons that occur at the Hanford Site. Natural phenomenon includes tornados, earthquakes, wind and volcanos.

32487 (CONF-8510118—, pp 59-62) **Analysis and design of Fuel Cycle Plant for natural phenomena hazards.** Horsager, B.K. (Westinghouse Hanford Co., Richland, WA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

A description of the Design Basis and the analysis and design methods used for natural phenomena at the Fuel Cycle Plant at Hanford, Washington is presented. A physical description of the main process facility and the auxiliary emergency and support facilities is given. The mission of the facility is presented and a brief description of the processes which will take place within the facility is given. The Design Criteria and design bases for natural phenomena including tornados, earthquakes and volcanic eruptions are described.

32488 (CONF-8510118—, pp 63-69) **Seismic vulnerability study of the nation's uranium enrichment plants.** Beavers, J.E.; Hines, T.M.; Casari, R.B.; Sheffey, D.W. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The US Department of Energy's uranium enrichment production is accomplished with three gaseous diffusion plants located at Oak Ridge, Tennessee; Paducah, Kentucky; and Portsmouth, Ohio. The plants were built in the 1940's and 1950's with no seismic design requirements and are located in three different seismic zones. Paducah is in the New Madrid seismic zone (UBC-Zone 3), Oak Ridge is in the Southern Appalachian seismic zone (UBC-Zone 2) and Portsmouth is near the Anna, Ohio seismic zone (UBC-Zone 1). This paper discusses the approach that was used to determine the seismic vulnerability of each of the plants in response to safety and operability analysis studies. Using state-of-the-art seismic evaluation methods, the study showed that the plants are more resistant to seismic excitation than previously thought. However, the study also showed that small seismic excitations could cause any one of the plants to shut down because of weak links in the process systems. It was determined that for about $6 million each, the Oak Ridge and Paducah plants could be upgraded to provide continuity of operation and operational safety at the evaluation basis earthquake levels. At Portsmouth the upgrade costs were determined to be about $1 million, much less than Paducah or Oak Ridge because of process equipment uniqueness.

32489 (CONF-8510118—, pp 70-75) **Natural phenomena risk assessment at Rocky Flats Plant.** Foppe, T.L. (Rockwell International, Golden, CO). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

A realistic approach is currently being used at the Rocky Flats Plant to assess the risks of natural phenomena events. The methodology addresses frequency of occurrence estimates, damage stress on the facility and vital equipment, material-at-risk, release fractions and source terms, leakpath, dispersion and dosimetric models, risk curves, and an uncertainty analysis. 28 references, 1 figure.

32490 (CONF-8510118—, pp 76) **Design considerations and adaptations for development in the flood plains.** MacAllen, T.C. (URS Company Inc., Montavale, NJ). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

As our nation continues to expand and non flood prone land becomes scarce, there is a growing need to place structures within natural flood plains. Nearly 90% of all damages stemming from natural disasters are a result of flooding. The National Flood Insurance program has established specific design criteria that must be met in order to build in the flood plain as defined by the aerial extent of the 100-year flood. Specific design considerations to be considered involve both site and flood characteristics. These considerations incorporate the hydrostatic, momentum and uplift forces associated with flooding. Design adaptations basically consist of elevating the structures through the use of fill piers or piles, but more innovative solutions are possible.

32491 (CONF-8510118—, pp 78-82) **Seismic upgrading of the Brookhaven High Flux Beam Research Reactor.** Subudhi, M. (Brookhaven National Lab., Upton, NY). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

In recent years the High Flux Beam Research (HFBR) reactor facility at Brookhaven National Laboratory (BNL) was upgraded from 40 to 50 MW power level. The reactor plant was built in the early sixties to the seismic design requirements of the period, using the static load approach. While the plant power level was upgraded, the seismic design was also improved according to current design criteria. This included the development of new floor response spectra for the facility and an overall seismic analysis of those systems important to the safe shutdown of the reactor. Items included in the reanalysis are the containment building with its internal structure, the piping systems, tanks, equipment, and heat exchangers. This paper describes the procedure utilized in developing the floor response spectra for the existing facility. Also included in the paper are the findings and recommendations, based on the seismic analysis, regarding the seismic adequacy of structural and mechanical systems vital to achieving the safe shutdown of the reactor. 11 references, 4 figures, 1 table.

32492 (CONF-8510118—, pp 83) **Facilities upgrade for natural forces: traditional vs. realistic approach.** Terkun, V. (Rockwell International, Golden, CO). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The traditional method utilized for upgrading existing buildings and equipment involves the following steps: performs structural study using finite element analysis and some in situ testing; compare predicted member forces/stresses to material code allowables; determine strengthening schemes for those structural members judged to be weak; estimate cost for required upgrades. This approach will result in structural modifications that are not only conservative but very expensive as well. The realistic structural evaluation approach uses traditional data to predict structural weaknesses as a final step. Next, using considerable information now available for buildings and equipment exposed to natural hazards, engineering judgments about structures being evaluated can be made with a great deal of confidence. This approach does not eliminate conservatism entirely, but it does reduce it to a reasonable and realistic level. As a result, the upgrade cost goes down without compromising the low risk necessary for vital facilities.

32493 (CONF-8510118—, pp 84-87) **Lawrence Berkeley Laboratory upgrading approaches to existing facilities.** Engle, H.M. Jr. (Engle & Engle Structural Engineers, San Rafael, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The Lawrence Berkeley Laboratory Plant Engineering Department instituted a seismic risk investigation and seismic upgrade program in 1970. This paper covers the upgrade of two buildings with dissimilar framing systems; Building No. 10, a World War II vintage heavy timber frame building, and Building No. 80, a steel frame structure constructed in 1954. The seismic upgrade task for both structures required that the buildings be kept in service during rehabilitation with a minimum of disruption to occupants. Rehabilitations were phased over two and three year periods with construction management and supervision performed by LBL Plant Engineering staff.

32494 (CONF-8510118—, pp 88-97) **Earthquake safety program at Lawrence Livermore National Laboratory.** Freeland, G.E. (Lawrence Livermore National Lab., CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557. Contract W-7405-ENG-48.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Within three minutes on the morning of January 24, 1980, an earthquake and three aftershocks, with Richter magnitudes of 5.8, 5.1, 4.0, and 4.2, respectively, struck the Livermore Valley. Two days later, a Richter magnitude 5.4 earthquake occurred, which had its epicenter about 4 miles northwest of the Lawrence Livermore National Laboratory (LLNL). Although no one at the Lab was seriously injured, these earthquakes caused considerable damage and disruption. Masonry and concrete structures cracked and broke, trailers shifted and fell off their pedestals, office ceilings and overhead lighting fell, and bookcases overturned. The Laboratory was suddenly immersed in a site-wide program of repairing earthquake-damaged facilities, and protecting our many employees and the surrounding community from future earthquakes. Over the past five years, LLNL has spent approximately $10 million on its earthquake restoration effort for repairs and upgrades. The discussion in this paper centers upon the earthquake damage that occurred, the clean-up and restoration efforts, the seismic review of LLNL facilities, our site-specific seismic design criteria, computer-floor upgrades, ceiling-system upgrades, unique building seismic upgrades, geologic and seismologic studies, and seismic instrumentation. 10 references.

32495 (CONF-8510118—, pp 98-101) **Use of walk through procedures to minimize seismic upgrade for nuclear facilities.** Djordjevic, W. (Stevenson and Associates, Boston, MA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The seismic evaluation Walk Through Procedure briefly described in this paper can be used to dramatically reduce seismic evaluation efforts. The procedure makes maximum use of existing extensive generic data bases which define seismic fragility or ruggedness while at the same time utilize component and site specific field inspections of each component and its environs. It is recommended that the Walk Through procedure outlined herein be considered as a primary method of evaluating the seismic capabilities of nuclear facilities in the future. 7 references, 4 figures.

32496 (CONF-8510118—, pp 104-110) **Base isolation: a new strategy for earthquake protection of buildings.** Tarics, A.G. (Reid & Tarics Associates, Inc., San Francisco, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

A new strategy in seismic engineering, called Base Isolation, is revolutionizing the way buildings are engineered in earthquake-prone areas. Buildings are mounted on rubber-steel combination shock-absorbing pads, which prevent most of the horizontal movement of the ground from being transmitted to the building. Contrary to conventional design, the loose contents of the buildings are also protected, therefore, buildings will remain undamaged and functional after earthquakes. 18 references, 8 figures.

32497 (CONF-8510118—, pp 112-121) **Structural observations of the March 3, 1985 Chilean earthquake.** Wyllie, L.A. Jr. (H.J. Degenkolb Associates, San Francisco, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

A damaging earthquake of tentative magnitude 7.4 occurred on March 3, 1985, several kilometers offshore of central Chile. The area of strong ground shaking included Santiago, Valparaiso and nearby communities which comprise the most densely populated portion of Chile. Ground motion was strong and of long duration, with one instrument near the coast south of the epicenter recording peak accelerations reported at 0.80 g vertical and 0.65 g horizontal. The earthquake affected many modern buildings of reinforced concrete construction as well as some buildings of other materials. Adobe buildings were heavily damaged and accounted for the majority of the homeless, which reportedly was several hundred of thousands of people. However, the death toll was under 200. Of particular interest are the large number of modern reinforced concrete buildings which performed extremely well in this earthquake. Most of the buildings were rigid shear wall structures with a substantial amount of structural wall. The most modern buildings were generally well detailed for ductile performance. A portion of one building in the five-story Villa Olympia housing complex in Santiago collapsed, an eight-story building in the seaside resort of Vina del Mar was dynamited as it was leaning considerably and several pedestrian bridges between buildings in another Vina del Mar housing complex collapsed. These were the only collapses of reinforced concrete structures observed in this severe earthquake. Some interesting structural damage occurred to other selected structures. 22 figures.

32498 (CONF-8510118—, pp 122-131) **Structural performance of the DOE's Idaho National Engineering Laboratory during the 1983 Borah Peak Earthquake.** Guenzler, R.C.; Gorman, V.W. (Idaho National Engineering Lab., Idaho Falls). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557. Contract AC07-76ID01570.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The 1983 Borah Peak Earthquake (7.3 Richter magnitude) was the largest earthquake ever experienced by the DOE's Idaho National Engineering Laboratory (INEL). Reactor and plant facilities are generally located about 90 to 110 km (60 miles) from the epicenter. Several reactors were operating normally at the time of the earthquake. Based on detailed inspections, comparisons of measured accelerations with design levels, and instrumental seismograph information, it was concluded that the 1983 Borah Peak Earthquake created no safety problems for INEL reactors or other facilities. 10 references, 16 figures, 2 tables.

32499 (CONF-8510118—, pp 132-139) **Earthquake experience data on power and industrial structures: applications to seismic design and evaluation.** Roper, S.C.; Yanev, P.I. (EQE Inc., San Francisco, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

An extensive study was conducted to document the seismic performance of typical power plant and industrial structures in selected recent strong earthquakes and to correlate the performance of each structure to the seismic criteria to which it was designed. A total of 150 structures which were subjected to earthquakes producing site peak ground accelerations (PGAs) in the range of 0.20 to 0.60g, were examined. The construction types reviewed include steel braced frames, reinforced concrete turbine pedestals, wood cooling towers, and vertical cylindrical steel tanks. All data base structures were designed between 1940 and 1969 by Uniform Building Code (UBC) type static lateral force methods. Although the structures were subjected to PGAs up to 4.5 times greater than their design static lateral force coefficients, damage was generally nonexistent or minimal. In all but one case (a deteriorated wood

cooling tower), the seismic performance of the data base structures did not adversely affect facility operation or endanger personnel safety. The data base information demonstrates that UBC type seismic design criteria, when properly applied, can provide a high level of seismic protection for power plant and industrial structures. The established data base of earthquake affected structures provides a valuable tool for realistically evaluating seismic risks in existing facilities and for establishing appropriate seismic design criteria for new facilities.

32500 (CONF-8510118—, pp 140-149) **Performance of structures during Hurricane Alicia and the Altus Tornado.** Marshall, T.P. (Haag Engineering Co., Carrollton, TX). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Investigation of building damage from Hurricane Alicia and the Altus, Oklahoma Tornado revealed similarities in structural performance. Variability in construction practices and inherent uncertainties in structural materials played an important role in determining why one building survived unscathed while an adjacent building was heavily damaged. Attention to detail like the installation of anchor bolts or tie down straps helped explain the large variation in damage. Observed modes of building failure in the two different windstorms are presented. Distinction between wind and wave damage in Hurricane Alicia is discussed. Suggestions are presented to help minimize structural damage due to wind and wave forces in the future. The second portion of this paper presents a methodology for computing failure wind speeds using a probabilistic approach which incorporates load and resistance statistics. Upper and lower bound wind speed estimates are obtained with a desired degree of confidence. Calculated wind speeds have been consistent with the type of structural damages observed. 15 references, 11 figures, 3 tables.

32501 (CONF-8510118—, pp 196) **Specification of seismic qualification environment for equipment.** Johnson, J.J.; Maslenikov, O.R.; Mraz, M.J.; Benda, B.J. (NTS/Structural Mechanics Associates, San Ramon, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Specification of the seismic qualification environment for equipment housed in structures may be in the form of in-structure response spectra. Current procedures are to calculate a raw in-structure response spectra, smooth, and peak broaden it to account for uncertainties in the seismic input, soil, and structure properties. This procedure many times leads to excessive conservatism in response spectra at frequencies near peak amplification. They do not lead to equal probability of exceedance spectra. These spectra are especially sensitive to changes in earthquake motions or other dynamic excitations and changes in soil and structure modeling and behavior. Peak broadening in-structure response spectra 15% may not cover the range of frequencies of the soil-structure system, in general. However, applying peak broadening to the extremely high peaks of the spectra leads to very conservative in-structure spectra for design. A more rational approach based on equal probability of exceedance response spectra is presented. An example structure is analyzed and three sets of results presented and compared: current procedures, design spectra based on approximately 16% exceedance probability, and design spectra based on a factored median response spectra.

32502 (CONF-8510118—, pp 197) **Cost-reducing seismic qualification program for the Gas Centrifuge Enrichment Plant (GCEP).** Drake, R.M.; Swan, S.W.; Smietana, E.A. (Fluor Engineers and Constructors, Inc., Irvine, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

In an effort to reduce costs, the seismic qualification program for DOE's Gas Centrifuge Enrichment Plant (GCEP) near Portsmouth, Ohio has been recently updated. The new program maximizes architect/engineer (A/E) responsibility for seismic qualification and thereby minimizes the construction contractor's, and thus the equipment supplier's involvement in the qualification process. For most equipment items, it can be shown that industry standard practice in equipment design is sufficient to assure adequate seismic integrity and a high probability of continued operation during and after a seismic event. Thus, much of the usual testing and analysis by the equipment supplier on nuclear-related projects is avoided, and minimal calculations (primarily for base anchorage) are performed by the A/E. A key element in this qualification approach is the use of seismic experience data developed through an ongoing research program sponsored by the nuclear power industry. Experience in the performance of most types of equipment in earthquakes shows that damage or malfunction occurs far less often than conventional analysis would predict. Equipment seems to be highly resistant to the effects of seismic inertial loads where adequate base anchorage is provided. In addition to seismic experience data, the use of past qualification program experience, design calculation as based on a generic item configuration (i.e. one representative of several manufacturers), and engineering judgment is an important part of the qualification process.

32503 (CONF-8510118—, pp 199) **Seismic considerations for suspended ceiling systems.** Freeland, G.E.; Wong, P.W.T.; Earle, J. (Lawrence Livermore National Lab., CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Since Lawrence Livermore National Laboratory is engaged in sophisticated research and development activities and its geographic location makes the laboratory subject to the effect of earthquakes, in October 1984, ED2 International Architects and Planners were commissioned by LLNL to provide a Survey of commercially available suspended ceiling systems. The Survey was to include all ceilings types, their relative costs, and recommendations for seismic design. This Survey is in the format of a handbook with seven major headings: generic types of suspended ceiling systems; functional comparative analysis of the various systems; relative costs of various ceiling systems; seismic considerations and recommendations; detailed drawings and suggested methods of assembly; code references; listing of material suppliers, representatives, and available product lines and selection check lists. This Survey of ceiling systems was intended to be used as a guide and a working document for the comparison of available systems. In addition, it was meant to serve as a valuable tool in establishing a definitive code with applicable standards and design criteria for suspended ceiling systems at the laboratory. The work in progress also has replication value to other DOE facilities.

32504 (CONF-8510118—, pp 202-209) **Overview of the probabilistic risk assessment approach.** Reed, J.W. (Jack R. Benjamin & Associates, Mountain View, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The techniques of probabilistic risk assessment (PRA) are applicable to Department of Energy facilities. The background and techniques of PRA are given with special attention to seismic, wind and flooding external events. A specific application to seismic events is provided to demonstrate the method. However, the PRA framework is applicable also to wind and external flooding. 3 references, 8 figures, 1 table.

32505 (CONF-8510118—, pp 210-213) **Standardization of natural phenomena risk assessment methodology at the Savannah River Plant.** Huang, J.C.; Hsu, Y.S. (E.I. du Pont de Nemours and Co., Aiken, SC). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557. Contract AC09-76SR00001.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Safety analyses at the Savannah River Plant (SRP) normally require consideration of the risks of incidents caused by natural events such as high-velocity straight winds, tornadic winds, and earthquakes. The probabilities for these events to occur at SRP had been studied independently by several investigators, but the results of their studies were never systematically evaluated. As part of the endeavor to standardize our environmental risk assessment methodology, these independent studies have been thoroughly reviewed

and critiqued, and appropriate probability models for these natural events have been selected. The selected probability models for natural phenomena, high-velocity straight winds and tornadic winds in particular, are in agreement with those being used at other DOE sites, and have been adopted as a guide for all safety studies conducted for SRP operations and facilities. 7 references, 3 figures.

32506 (CONF-8510118—, pp 214) **Tornado risk analysis at Savannah River Plant using windspeed damage thresholds and single building strike frequencies.** Taylor, D.H.; McDonald, J.R.; Twisdale, L.A. (E.I. du Pont de Nemours & Co., Aiken, SC). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Tornado risk analysis at the Savannah River Plant has taken a two pronged approach: (1) developing a catalogue of damage thresholds as a function of windspeed for processing buildings and other representative site structures; (2) developing a method of estimating, for each building, the probability of a tornado exceeding each damage threshold. Wind resistance of building construction at SRP varies widely depending on the function of the structure. It was recognized that all tornadoes do not necessarily seriously damage buildings, but the damage thresholds were unknown. In order to evaluate the safety of existing structures and properly design new structures, an analysis of tornado resistance was conducted by J.R. McDonald on each process building at SRP and other buildings by type. Damage estimates were catalogued for each Fujita class windspeed interval and windspeeds were catalogued as a function of increased levels of damage. Tornado single point and structure specific strike probabilities for the SRP site were determined by L.A. Twisdale using the TORRISK computer code. To calculate the structure specific strike probability, a correction factor is determined from a set of curves using building area and aspect ratio (length/width relative to north) as parameters. The structure specific probability is then the product of the correction factor and the point probability. The correction factor increases as a function of building size and windspeed. For large buildings (10^5 ft ^{2}) and very intense storms (250 mph), the correction factor is equal to or greater than 4. The cumulative probability of a tornado striking any building type (process, personnel, etc.) was also calculated.

32507 (CONF-8510118—, pp 215) **Risk assessment methodology for extreme wind and missile effects on critical facilities.** Twisdale, L.A.; Dunn, W.L. (Applied Research Associates, Inc., Raleigh, NC). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The TORMIS methodology has been applied to a number of probabilistic risk assessments of critical facilities in the continental United States. These analyses have centered on the estimation of tornado missile impact and damage risks to individual targets as well as to groups of targets at specific plants. A number of advancements and generalizations in the approach have recently been made. These include: (1) generalization of windfield options to include straight winds (WINMIS) and hurricanes (HURMIS); (2) generalization of the scoring to enable analysis of Boolean system expressions for damage probabilities on compound series and parallel safety trains; (3) generalization of the failure criteria to include wind pressure as well as missile impact; (4) generalization of the plant modeling capability to enable more detailed treatment of targets partially or fully enclosed by vulnerable cladding and to allow tracking of missiles inside such enclosures; and (5) incorporation of windspeed criteria for structural failure and subsequent production of potential missiles. This paper will present some of the basic theory and key results of recent TORMIS, WINMIS, and HURMIS applications. The influence of uncertainties in the estimation process and the data needed for plant-specific risk assessments will also be discussed.

32508 (CONF-8510118—, pp 216-219) **Review of seismic probabilistic risk assessment and the use of sensitivity analysis.** Shiu, K.K.; Reed, J.W.; McCann, M.W. Jr. (Brookhaven National Lab., Upton, NY). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

This paper presents results of sensitivity reviews performed to address a range of questions which arise in the context of seismic probabilistic risk assessment (PRA). In a seismic PRA, sensitivity evaluations can be divided into three areas: hazard, fragility, and system modeling. As a part of the review of standard boiling water reactor seismic PRA which was performed by General Electric (GE), a reassessment of the plant damage states frequency and a detailed sensitivity analysis were conducted at Brookhaven National Laboratory. The rationale for such an undertaking is that in this case: (1) the standard plant may be sited anywhere in the eastern US (i.e., in regions with safety shutdown earthquake (SSE) values equal to or less than 0.3g peak ground acceleration), (2) it may have equipment whose fragility values could vary over a wide range; and (3) there are variations in system designs outside the original defined scope. Seismic event trees and fault trees were developed to model the different system and plant accident sequences. Hazard curves which represent various sites on the east coast were obtained; alternate structure and equipment fragility data were postulated. Various combinations of hazard and fragility data were analyzed. In addition, system modeling was perturbed to examine the impact upon the final results. Orders of magnitude variation were observed in the plant damage state frequency among the different cases. 7 references, 3 figures, 2 tables.

32509 (CONF-8510118—, pp 222-228) **Progress towards developing consistent design and evaluation guidelines for DOE facilities subjected to natural phenomena hazards.** Kennedy, R.P.; Short, S.A.; McDonald, J.R.; McCann, M.W. Jr.; Reed, J.W. (NTS/Structural Mechanics Associates, Newport Beach, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

Probabilistic definitions of earthquake, wind and tornado natural phenomena hazards for many Department of Energy (DOE) facilities throughout the United States have been developed. In addition, definitions of the flood hazards which might affect these locations are currently being developed. The Department of Energy Natural Phenomena Hazards Panel is now preparing a document to provide guidance and criteria for DOE facility managers to assure that DOE facilities are adequately constructed to resist the effects of natural phenomena such as earthquake, strong wind and flood. The intent of this document is to provide instruction on how to utilize the hazard definitions to evaluate existing facilities and design new facilities in a manner such that the risk of adverse consequences is consistent with the cost, function, and danger to the public or environment of the facility. Potential effects on facilities of natural phenomena hazards are emphasized in this paper. The philosophy for mitigating these effects to be employed in the design and evaluation guidelines is also presented.

32510 (DOE/PE/17056—T10) **Fire protection review. Revisit No. 2, Nevada Test Site, Las Vegas, Nevada. Technical report.** Dobson, P.H.; Earley, M.W.; Moore, L.J. (Factory Mutual Research Corp., Norwood, MA (USA)). May 1986. Contract AC01-84PE17056. 106p. NTIS, PC A06/MF A01; GPO Dep. File Number DE86009862.

This report summarizes findings of a fire protection review conducted during January 27-31, February 3-7, and February 24-27, 1986 at the NTS. The visit included (1) tour of the facility; (2) water tests; (3) review of records of testing and inspection of fire protection equipment; and (4) tests of selected fire protection equipment to verify equipment had been properly tested and inspected. One fire loss in excess of $50,000,000 is possible. T-Tunnel has extensive quantities of wood lagging. A fire occurring when equipment is in place or mostly in place would result in severe damage to instrumentation, control and monitoring equipment for the specific event test and would delay future planned events. Replacement of lagging with a noncombustible material would substantially reduce the loss potential. The major deficiencies noted were lack of: (1) a cutting and welding permit system; (2) fixed protection for tunnel alcove areas such as splicing rooms, instrumentation alcoves and storage areas; (3) adequate protection for assembly towers; and

(4) automatic halon protection for several computer, control and critical telephone switchgear rooms.

32511 **(KFK—4015) Criteria for unstable crack extension under displacement control.** Munz, D.; Brueckner, A. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Material- und Festkoerperforschung). Dec 1985. 42p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751749.

Cracks in components can extend under load or displacement control. Under displacement control usually the cracks extend first stable under decreasing load and afterwards unstably. The critical load for the onset of unstable cracks extension is dependent on the material, the geometry of the crack and of the component and on the compliance of the loading system. In this report general criteria for the relation between compliance and cracks size are developed. In particular the relations for linear-elastic fracture mechanics for flat and rising crack growth resistance curves, the plastic instability criterion and the J-integral methods are discussed. (orig.).

4208 Electronic Circuits And Devices

REFER ALSO TO CITATION(S) 32447

32512 **(SAND—86-0323C) Compound semiconductor strained-layer superlattices.** Dawson, L.R. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-860622—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007145.

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

Strained-layer superlattice structures allow a much wider range of semiconductor device structures, as well as the opportunity to tailor materials and device properties in unique ways. Various device applications will be discussed.

32513 **(SAND—86-0825) TA683 test chip layout documentation.** Gerber, D.S.; Hampy, R.E.; Renninger, D.J. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 63p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010311.

The TA683 is designed to be a technology development test chip for the CMOS IIIC, CMOS IV, and SOI technologies.

32514 **(UCID—20728) Transmission of a modulated microwave across a diode.** Orvis, W.J.; Yee, J.H.; Khanaka, G.H. (Lawrence Livermore National Lab., CA (USA)). Jan 1986. Contract W-7405-ENG-48. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010262.

Using the one-dimensional, solid state device model, BURN42, we have modeled the transmission of microwaves in the 3 Gigahertz (GHz) range, modulated with lower frequency rf in the 50 Megahertz (MHz) range passed a small signal diode. The results indicate that no matter what the state of the diode (avalanching - not avalanching; switching - not switching) that energy is transferred from the low frequency modulation to a distinct, low frequency signal in the diode voltage. The diode voltage also contains a number of harmonics of the high frequency. 22 figs.

32515 **Chemical preparation and properties of high-field zinc oxide varistors.** Dosch, R.G.; Tuttle, B.A.; Brooks, R.A. (Sandia National Laboratories, P. O. Box 5800, Albuquerque, New Mexico 87185). *Journal of Materials Research;* 1: No. 1, 90-99(Jan 1986). Contract AC04-76DP00789.

Chemical preparation methods were developed for high-field ZnO varistors which used precipitation techniques to prepare precursor powders. Varistors were made by sintering uniaxially pressed pellets in the range of 675°-740 °C in air. Properties of these varistors included electric fields (E) in the 10-100 kV/cm range at current densities (J) of 5 A/cm², nonlinearity coefficients (α) greater than 30 for 2.5< or =J< or =5.0 A/cm², and densities in the range of 65%-99% of theoretical depending both on sintering temperature and composition.

4210 Combustion Systems

REFER ALSO TO CITATION(S) 31346, 31371, 31776, 32089, 32400

32516 **(AD-A—164292/5/XAB) Measurements and designs related to electrical spray modification in a T-56 combustor. Contractor report, August 1984-September 1985.** (Naval Postgraduate School, Monterey, CA (USA)). Dec 1985. 58p. (NPS—67-85-012CR). NTIS, PC A04/MF A01.

A new optical technique for measuring Sauter mean-diameter changes of a fuel spray under an electrostatic field was checked, calibrated, and implemented. The optical technique is based on measuring scattered light at two angles using a variable focal-length apparatus. Special attention was given to improving the electrical control loop parameters in order to minimize measurement errors. In order to measure more realistically the effects of the electrostatic probe inside a gas turbine combustor, a pressure chamber was added to the outlet of the present combustion-simulation device. Hot tests were carried out with diesel fuel DF-2. Pressure chamber, combustor's temperatures, fuel, and air mass flow rates, were recorded together with the voltage applied at the electrode. Results of the cold tests with the new optical device show a Sauter mean diameter of 50.0 micron at fuel pressure (DF-2) of 100 psi, 51.7 micron at 125 psi and 47.8 micron at 80 psi. The device could not resolve changes while the high voltage field was exerted. Combustion temperatures with the pressure chamber are presented. Preliminary designs for improvements of the various devices are also described.

32517 **(PB—86-157153/XAB) Ir (infrared) fuel/air control for methane combustors. Annual report, May 1984-May 1985.** Zabielski, M.F. (SEE CODE- 9501195 United Technologies Corp., East Hartford, CT (USA). Research Center). 31 May 1985. 81p. (R—85-956821-10). NTIS, PC A05/MF A01.

Infrared-emission data as a function of fuel/air ratio are provided for fully premixed, partially premixed, and swirl-driven diffusion burners. Data from all three burners displayed characteristics suitable for a hill-climbing control scheme. A control algorithm was developed for use on an Apple IIE/ISAAC computer system. Phase-sensitive detection was implemented in software. The control algorithm was demonstrated on a flat flame burner modified with an air-injector located on centerline to modulate the stoichiometry.

32518 **(PB—86-159852/XAB) Environmental assessment of NH_3 injection for an industrial package boiler. Volume 1. Technical results. Final report, January 1983-January 1984.** Castaldini, C.; DeRosier, R.; Waterland, L.R. (Acurex Corp., Mountain View, CA (USA). Energy and Environmental Div.). Feb 1986. 114p. (ACUREX/TR—83-139/EE). NTIS, PC A06/MF A01.

The report discusses emission results from comprehensive flue gas sampling of a gas- and oil-fired industrial boiler equipped with Exxon's Thermal DeNOx Ammonia Injection Process for NOx reduction. Comprehensive emission measurements included continuous monitoring of flue gas emissions; source assessment sampling system (SASS) tests; EPA Method 5/17 for solid and condensible particulate emissions and ammonia emissions; controlled condensation system for SO_3 and SO3; and N_2O emission sampling. Ammonia injection at a NH_3/NO molar ratio of 2.52 gave a NOx reduction of 41% from an uncontrolled level of 234 ppm to a controlled level of 137 ppm. NH3 emissions increased from 11 ppm for the baseline to an average of 430 ppm for ammonia injection. Nitrous oxide, N2O, was reduced 68% from a 50 ppm baseline level to a 17 ppm controlled level. Total particulate emissions increased by an order of magnitude from a baseline of 17.7 ng/J to a controlled level of 182 ng/J. The increase is in part attributed to formation of ammonia sulfate and bisulfate from residual ammonia and SOx. Total organic emissions were at a moderate level and showed a relative concentration in the nonvolatile category. Organic emissions of CO and trace inorganic elements were not significantly affected by ammonia injection.

32519 **Drop short control of electrode gap.** Fisher, R.W.; Maroone, J.P.; Tipping, D.W.; Zanner, F.J. (to Dept. of Energy, Washington, DC). US Patent 4,578,795. 25 Mar 1986. Filed date 28 Dec 1982. vp.

A process is described of controlling the position of a consumable electrode in a consumable electrode furnace having an arc struck between the consumable electrode and a molten pool of material. The process consists of: monitoring the voltage across the arc to produce a monitored voltage signal; detecting the occurrence of drop shorts by comparing the monitored voltage signal to a drop short detection threshold signal and producing a drop short signal; determining the average period between drop shorts from the drop short signal; determining the actual electrode gap by non-invasive means using the average period and a drop short period electrode gap model slope and intercept; comparing the actual electrode gap with a desired electrode gap value and controlling the position of the consumable electrode based upon the comparison.

32520 **Combustion equipment research.** Andrews, J.W. (Brookhaven National Lab., Upton, NY). *Energy Technology (Washington, D.C.);* **12**: 908-917(Aug 1985). (CONF-850301—).

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

Brookhaven National Laboratory's Space Conditioning Technology Program refocused in 1982 from technology assessment to generic research. The new program expanded work on corrosion-resistant materials for condensing systems, and began work on sooting in oil-fired systems and distribution systems technology. The latter has expanded in importance since it is the major remaining area in which significant energy savings can be effected through generic research. The author summarizes recent work, and discusses major thrusts for future efforts in each area. 9 references.

4220 Underground Engineering

32521 **(LA-UR—86-771) Thermal spallation excavation of rock.** Williams, R.E. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 6p. (CONF-860609—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007367.

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

This review discusses the uses and potentialities of thermal spallation to excavate deep holes in hard rock. Historical experiences, technological improvements, and economics are focused on. (ACR)

4230 Marine Engineering

32522 **(GKSS—85/E/52) Welding robots for underwater use.** Aust, E.; Szelagowski, P. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Anlagentechnik). 1985. 16p. (In German). (CONF-8506279—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86752027.

From Seminar on higher flexibility of industrial robots in submerged-arc welding; Frankfurt am Main, F.R. Germany (10 Jun 1985).

Presently the maximum working depth for manned dives seems to be at 600-700 m sea water. For greater water depths new techniques have to be developed in order to unburden and, for the long run, to replace divers. The GKSS-Forschungszentrum presently works on technical solutions from the area of computer controlled handling-systems for automatically performance of operations like under water welding. Based on diver performed under water welding techniques a development is presented, which in the first step is focused on automatically welding by orbital- and robot-systems under dry hyperbaric conditions. (orig.).

4240 Pollution Control Equipment

REFER ALSO TO CITATION(S) 31784, 31786

4250 Power Cycles

REFER ALSO TO CITATION(S) 31736, 32085

43 PARTICLE ACCELERATORS

4301 Design, Development, And Operation

REFER ALSO TO CITATION(S) 31514, 31619

32523 **(DOE/ER—0263) Nuclear physics accelerator facilities.** (USDOE Office of Energy Research, Washington, DC. Nuclear Physics Div.). Mar 1986. 38p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86009053.

Brief descriptions are given of DOE and Nuclear Physics program operated and sponsored accelerator facilities. Specific facilities covered are the Argonne Tandem/Linac Accelerator System, the Tandem/AGS Heavy Ion Facility at Brookhaven National Laboratory, the proposed Continuous Beam Accelerator at Newport News, Virginia, the Triangle Universities Nuclear Laboratory at Duke University, the Bevalac and the SuperHILAC at Lawrence Berkeley Laboratory, the 88-Inch Cyclotron at Lawrence Berkeley Laboratory, the Clinton P. Anderson Meson Physics Facility at Los Alamos National Laboratory, the Bates Linear Accelerator Center at Massachusetts Institute of Technology, the Holifield Heavy Ion Research Facility at Oak Ridge National Laboratory, the Nuclear Physics Injector at Stanford Linear Accelerator Center, the Texas A and M Cyclotrons, the Tandem/Superconducting Booster Accelerator at the University of Washington and the Tandem Van de Graaff at the A.W. Wright Nuclear Structure Laboratory of Yale University. Included are acquisition cost, research programs, program accomplishments, future directions, and operating parameters of each facility. (DWL)

32524 (DOE/ER/40048—102-L4, pp 72) **Van de Graaff accelerator operations and development.** Amsbaugh, J.F.; Cromie, J.R.; Fauska, H.; Hodgkins, D.J.; Leach, D.D.; Linder, C.E.; Saling, G.E.; Schmidt, F.H.; Stowell, R.E.; Trainor, T.A.; Van Wechel, T. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Accelerator maintenance required during the past year has been quite routine. The charging belt presently in the machine seems to be the most long-lived the authors have had. As of April 15, 1984, this belt had run 19,300 hours. During the year from April 16, 1983 to April 15, 1984 the tandem operated 4842 hours. Other statistics of the accelerator operation are given.

32525 (DOE/ER/40048—102-L4, pp 72) **Cyclotron operations and development.** Cromie, J.R.; Fauska, H.; Lewellen, B.L.; Murano, R.; Rohrbaugh, G.J.; Stowell, R.E.; Weitkamp, W.G.; Wiest, P. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The 60 in. cyclotron is now in its 34th year of continuous operation. Maintaining the cyclotron in operating condition required installation of a new oscillator tube, replacement of the variac coils on the main magnet power supply and overhaul of the main magnet oil circulating pump. The new University Hospital clinical neutron therapy cyclotron is now operating so that cancer therapy operations at the 60 in. cyclotron stopped at the end of February, 1984. Calcium measurements will continue for the near future. The machine ran 908 hours between April 16, 1983 and April 15, 1984. Other statistics of cyclotron operations are given.

32526 (DOE/ER/40048—102-L4, pp 90) **Booster LINAC project: introduction.** Storm, D.W. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

During the past year the DOE awarded a contract to build the superconducting booster proposed in 1982. Although the majority of the funds ($8M) of the project are construction funds included in the DOE contract, part of the project is to be done with state funds ($1.03M) and part with the operating funds (3 FTE personnel as well as costs of prototyping the resonators). Therefore it is appropriate to outline the progress in this report. The overall design was changed somewhat from that described in last year's Annual Report. Instead of 12 split ring resonators optimized for beta = 0.10 and 12 for beta = 0.16, the author has chosen to use 16 quarter wave resonators optimized for beta = 0.09 and 16 for beta = 0.18. The quarter wave resonators, which have two accelerating gaps instead of the three of the split rings, have a wider transit time factor, which is favorable for accelerating a broader range of particle masses. The quarter wave resonators are to be built of lead plated copper, following the design of Ben-Zvi and Brennan.

32527 (DOE/ER/40048—102-L4, pp 91-93) **Design and construction of superconductor resonators.** Ben-Zvi, I.; Goliak, T.; Holmgren, D.W.; Storm, D.W. (Weizmann Institute, Rehovot, Israel). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

A low beta resonator was fabricated at the Nuclear Physics Laboratory, then plated and successfully tested at Stony Brook. The basic design is a quarter wave, cylindrical cavity excited by a magnetic coupling loop. Before the copper prototype was made the exact design parameters were measured by the construction and RF testing of a brass model.

32528 (DOE/ER/40048—102-L4, pp 93-94) **Lead plating of the low beta resonator.** Brennan, J.M.; Corcoran, D.; Coughlin, R.; Goliak, T.; Hodgkins, D.; James, P.; Seamster, A.G.; Secora, J.H. (State Univ. of New York, Stony Brook). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Plating operations were performed at the lead plating facility at SUNY, Stony Brook. Initial procedures were based on the previous experience of prototype development by Ben-Zvi and Brennan. Several attempts were made to produce satisfactory results, however the lead surfaces were consistently stained and lacked the bright metallic finish routinely achieved with the split loop resonator at SUNY. The development of a new set of procedures was initiated, aided by reports of plating success from Ben-Zvi. Controlled tests were conducted which suggested several changes in the plating parameters. Based on these results and suggestions from the staff at SUNY a new process was defined which was successful in producing the smooth reflective metallic surface known to be necessary forla optimum resonator performance. Following a successful repair of the the crack, the prototype was plated and chemically polished with the new techniques. The resultant surface was highly reflective and free of stains and particulates. The subsequent prototype cold test was successful.

32529 (DOE/ER/40048—102-L4, pp 94-96) **Tests of the low beta resonator.** Brennan, J.M.; Goliak, T.; Storm, D.W. (State Univ. of New York, Stony Brook). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The low beta resonator was tested three times at Stony Brook between mid February and early April, 1984. The first two tests were unsuccessful in that fields only in the neighborhood of 1 MV/m were obtained with reasonable (less than 10 W) power in the resonator. In both cases the plating was poor. After techniques were developed to give good plating and after drilling out a crack in the bulk material of the resonator, the testing was successful. The test procedure is described.

32530 (DOE/ER/40048—102-L4, pp 96-97) **Pretandem buncher.** Amsbaugh, J.; Sima, L.; Storm, D.W.; Stowell, R.E.; Van Wechel, T. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The LINAC booster will require beam from the tandem Van de Graaff bunched to a time width around 100 psec. The direct current beam from the ion sources will be bunched with a single-gap gridded, four-harmonic buncher. After acceleration through the tandem the resulting pulse width will be 1-2 nsec. Beam pulses will then be further bunched by a superconducting quarter wave resonator to the required width.

32531 (DOE/ER/40048—102-L4, pp 98-99) **Phase control system of the tandem-LINAC system.** Trainor, T.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Successful operation of the tandem-LINAC accelerator combination relies, among other things, on proper control of the relative phases of the time-varying components of the system. In the absence of noise sources it should be possible to adjust each component phase with respect to a master clock according to established criteria. If, in addition, there are sources of phase noise in the system then one or more servo loops are required to reduce the noise to an acceptable level. The result is that correct phases are established and then maintained indefinitely.

32532 (LA—10719-SR) **Accelerator technology program. Status report, October 1984-March 1985.** Jameson, R.A.; Schriber, S.O. (comps.). (Los Alamos National Lab., NM (USA)). Apr 1986. Contract W-7405-ENG-36. 58p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86008019.

Activities of the racetrack-microtron development programs are highlighted, one of which is being done in collaboration with the National Bureau of Standards and the other with the University of Illinois; the BEAR (Beam Experiment Aboard Rocket) project; work in beam dynamics; the proposed LAMPF II accelerator; and the Proton Storage Ring. Discussed next is radio-frequency and microwave technology, followed by activities in accelerator theory and simulation, and free-electron laser technology. The report concludes with a listing of papers published during this reporting period.

32533 (LBL—19100, pp 2-4) **Operations summary.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

During fiscal 1984, 6479 hours of beam time were provided to Bevalac and SuperHILAC research programs in nuclear science and biomedicine. Two hundred and thirteen scientists, representing 52 institutions, participated in 69 different experiments. As national facilities, the Bevalac and SuperHILAC are used by qualified researchers from around the world; about half of the available research time is used by scientists not affiliated with LBL. Beam time is apportioned by Program Advisory Committees, which review submitted proposals twice each year. In addition, the users have formed users associations for the purpose of exchanging information and recommending operational and procedural improvements.

32534 (LBL—19100, pp 15-16) **Reference designs study.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

In line with its charter, the Reference Designs Study, which preceded an actual decision to proceed with design R & D, (a) explored the technical feasibility of a 20 TeV x 20 TeV proton-proton collider, based on three different proposed magnet designs, (b) performed detailed cost estimates for each design, and (c) identified the R & D required to verify design calculations and technical assumptions. The magnet designs that were examined had maximum field strengths of 3, 5, and 6.5 T, and the design circumferences of the collider varied accordingly from 164 to 90 km. The estimated costs for facilities (excluding research equipment) based on these

three designs fell within the narrow range between $2.70 and $3.05 billion. The most important conclusion of the study, however, was that the basic principles of design used successfully for existing accelerators can be conservatively extended to a proton collider having the SSC primary specifications of energy and luminosity.

32535 (LBL—19100, pp 48-50) **Other experimental and developmental activities.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

An integral part of our experimental program is the investigation of fundamental phenomena that we expect to encounter as we move toward the HTE, as well as the development of materials and components that will be needed in advanced linacs. In the past year, this developmental work has focused on diagnostics, source designs, insulators and core materials. Experimental activities have been highlighted by continued work on collective-focusing effects and by the first phase of an experiment at the Bevalac that will ultimately yield range-energy data on low-charge-state heavy ions.

32536 (LBL—19100, pp 51-52) **Theory.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

Much of our theoretical program is directed toward simulations of space-charge-dominated beams, in particular, the transverse dynamics of such beams. These simulations may ultimately be tested on MBE-4. In addition, we continued our efforts to optimize the design of the HTE accelerator. In particular, we sought to limit the plausible choices of ion species and final energy, based on computer models of the target, final focus, and accelerator system.

32537 (LBL—19100, pp 65-66) **Free-electron laser.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

When a properly designed electromagnetic field is imposed on a beam of electrons, the electrons will give up kinetic energy in the form of coherent radiation. The result is a free-electron laser. Together with workers at Lawrence Livermore National Laboratory, we have now used an FEL to amplify 34.6-GHz microwave radiation several thousand-fold. This potential source of power has stimulated thinking about a new concept in linear colliders, namely, a two-beam accelerator. In such a device, the microwaves emitted from an FEL would be coupled by means of waveguides to an adjacent traveling-wave structure, where they would produce a high longitudinal electric gradient. In this structure, a second beam of electrons could be accelerated to very high energies.

32538 (LBL—19100, pp 69-70) **Minicollider.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

One of the most exciting prospects before nuclear physics today is the observation of the postulated quark-gluon plasma. To produce this state of matter, it is necessary to produce a nuclear temperature and baryon density sufficiently high to deconfine the elemental constituents of the nucleus. Current theory suggests that this can be done in at least two distinct ways, either at very high energies, which would produce high temperatures but low baryon densities, or at relatively low energies, which would produce very high baryon densities. During 1984 we tentatively investigated a design concept for a small heavy-ion collider - the Minicollider, to be injected by beams from the Bevalac - that would explore this second regime of nuclear states.

32539 (LBL-PUB—496-4-86) **BEVALAC operation's update.** (Lawrence Berkeley Lab., CA (USA)). 1986. Contract AC03-76SF00098. 12p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86009955.

Information is given on the operation and improvement of the BEVALAC, and about some of the supporting facilities, such as the electronics pool and a living/working facility at the accelerator. The status is given of an upgraded local injector, five individual beam lines, and the Plastic Ball Detector. (LEW)

32540 **Quest for ultrahigh energies.** Sessler, A.M. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *American Journal of Physics;* **54**: No. 6, 505-510(Jun 1986). Contract AC03-76SF00098.

A categorization is given of all the methods for accelerating particles. It is shown that in principle one can employ the large fields of a laser for this purpose as well as the wake fields of intense low-energy particle beams. Discussion is given of four acceleration schemes which offer the possibility of attaining very high-energy particles; namely, the inverse free-electron laser accelerator, the beat-wave accelerator, the wake-field accelerator, and the two-beam accelerator.

32541 **Transverse-field focusing accelerator.** Anderson, O.A. (Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 473-488(1 Mar 1984). (CONF-831180—). Contract AC03-76SF00098.

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

The essential facts about TTF transport and acceleration of particle beams as simply as possible are presented, it includes all the information needed to design a system.

32542 **Design desiderata for a laminar flow quadrupole-focused acceleration column.** Maschke, A.W. (Accelerator Department, Brookhaven National Laboratory, Associated University, Inc. Upton, New York 11973). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 489-491(1 Mar 1984). (CONF-831180—).

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

The design of a laminar flow quadrupole-focused acceleration column is studied.

32543 **BNL RFQ.** Giordano, S.T. (Accelerator Department, Brookhaven National Laboratory, Associated Universities, Inc., Upton, NY 11973). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 505-510(1 Mar 1984). (CONF-831180—).

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

A brief outline of the theoretical design has been presented at the Symposium. Particular emphasis has been placed on the RF design of the main cavity, end cells, and power feed. The relevance of the design has been considered with respect to the tuning and operating characteristics of the structure.

32544 **2D accelerator design for SITEX negative ion source.** Whealton, J.H.; Raridon, R.J.; McGaffey, R.W.; McCollough, D.H.; Stirling, W.L.; Dagenhart, W.K. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 524-532(1 Mar 1984). (CONF-831180—). Contract W-7405-ENG-26.

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

Solving the Poisson-Vlasov equations del^{2}phi = $\int$fdv-e/sup -phi/ (1) (v x B+delphi) x del/sub v/ f = v x delf = 0 (2) where the magnetic field, B, is assumed constant, we optimize the optical system of a SITEX negative ion source in ∞ slot geometry. Algorithms designed to solve the above equations were modified to include the curved emitter boundary data appropriate to a negative ion source. Other configurations relevant to negative ion sources are examined.

4302 Beam Dynamics, Field Calculations, And Ion Optics

REFER ALSO TO CITATION(S) 32541, 32542, 33260, 33390, 33391, 33392

32545 (AD-A—164272/7/XAB) Transport properties of relativistic electron beams through linearly polarized magnetic wigglers. Technical report, 1 October 1982-30 September 1983. Hu, Ren-Chau J.; Elias, Luis R. (California Univ., Santa Barbara (USA). Quantum Inst.). 1983. 8p. (QIFEL—019/82). NTIS, PC A02/MF A01.

When a relativistic electron beam moves through a linearly polarized magnetic wiggler it exhibits betatron oscillations along the direction perpendicular to the motion. There is also a small defocusing effect along the transverse direction because of space-charge repulsion. In this case with a low-emittance electron beam, computer simulation shows a negligible increase in emittance, although the phase space in the transverse plane may vary greatly from period to period because of the betatron effect.

32546 (AD-A—164275/0/XAB) Results of the UCSB FEL electron beam recirculation experiment. Technical report, 14 January 1982-13 January 1983. Elias, L.R. (California Univ., Santa Barbara (USA). Quantum Inst.). 1983. 7p. (TR—18,). NTIS, PC A02/MF A01.

Experiments demonstrating the generation and recirculation of a high-current low-emittance electron beam through the terminal of a Van De Graph type accelerator are described. Beam emittance approaching the theoretical limit for a thermionic cathode was achieved and a recirculation level of 96% was observed. Keywords: Free Electron Lasers.

32547 (DESY—85-140) Longitudinal-transverse mode coupling in localized structures with orbit dependent higher order mode losses. Kohaupt, R.D. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Nov 1985. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751741.

The mathematical properties of transverse mode functions leading to transverse mode coupling hold also in the case of longitudinal-transverse mode coupling. The interaction between transverse and longitudinal collective motion is governed by the transverse impedances and that part of the longitudinal impedance which depends on the orbit position, both related by Maxwell's equations. The expected effect will therefore strongly depend on closed orbit deviations, a characteristic property of the observed current limitations in PETRA. In this article the effect is studied theoretically in the framework of the Vlasow equation. (orig./HSI).

32548 (DOE/ER/40048—102-L4, pp 40-41) ^{14}N beam position stabilization system. Adelberger, E.G.; Hill, N.; Osborne, J.L.; Swanson, H.E.; Zeps, V.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The incoming proton beam is stabilized to remove position fluctuations. Using four independent control loops, the beam is dynamically steered to pass through the center of both the upstream slits and the Faraday cup. The major elements of the beam sensing and steering system are shown.

32549 (ITEF—175(1984)) Coherent collisions during in-beam Coulomb scattering. Zenkevich, P.R.; Korolev, A.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702040.

In beam Coulomb scattering of particles results in the redistribution of energy in the beam circulating in a cyclic accelerator or a storage ring. Pulse increments in sequential collisions of the given pair of particles can be intercorrelated due to the periodicity of particle transversal motion. This work is aimed at the assessment of effects related to such correlations. It is shown that coherent scattering effect conditioned by the correlation of pulse increments in sequential Coulomb collisions of two particles exists in beams with small puise distribution which circulate in cyclic accelerators and storage rings. Time relaxation correction related to the coherent scattering is estimated; its value depends on beam particles scattering over the longitudinal velocity and transversal oscillation frequencies.

32550 (ITEF—193(1984)) Solution of the two-dimensional Poisson equation using fast Fourier transformation in charged particle beam simulation. Vorob'ev, L.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 18p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702041.

In a number of problems of simulation of dynamics of intense beams of charged particles or plasma, it is necessary to define fields generated by particles themselves - intrinsic fields.

32551 (LBL—19100, pp 21-22) SSC accelerator physics. May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

Accelerator physicists at LBL began intensive work on the SSC in 1983, in support of the proposed 6.5-T magnet design, which, in turn, became reference design A during the Reference Designs Study. In that same study, LBL physicists formed the core of the accelerator physics group led by Fermilab's Don Edwards. In a period of only a few months, that group established preliminary parameters for a near-optimal design, produced conceptual designs based on three magnet types, addressed all significant beam lifetime and stability issues, and identified areas requiring further R & D. Since the conclusion of the Reference Designs Study, work has focused on the key SSC design issue, namely, single-particle stability in an imperfect magnetic field. At the end of fiscal 1984, much of the LBL accelerator physics group took its place in the SSC Central Design Group, whose headquarters at LBL will be the focus of nationwide SSC R & D efforts over the next several years.

32552 (LBL—19100, pp 23-24) Beam cooling. May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

In support of the Tevatron proton-antiproton collider project at Fermilab, we are designing, producing, and testing selected components for stochastic antiproton cooling. In particular, our efforts have concentrated on printed-circuit signal combiners and splitters, and on low-noise preamplifiers designed for operation at both 1-2 and 2-4 GHz.

32553 (LBL—19100, pp 44-45) Single-beam transport experiment. May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

The principal goal of the SBTE is to study the stability of a high-current beam of heavy ions (Cs^+) as it is transported through an array of quadrupole magnets. Initially, the destabilizing effect of mutual electrostatic repulsion was the main uncertainty, but results continue to support estimates of maximum transportable current - without deterioration of brightness - that are much higher than those suggested by simple theory. Also as part of the SBTE, we have measured the attenuation of the Cs^+ beam as a function of gas pressure, which has allowed us to measure both the electron-capture and electron-loss cross sections for the ion in nitrogen at 160 keV.

32554 (LBL—19100, pp 45-48) Multiple-beam experiment. May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

A self-consistent engineering design for a 16-beam MBE was completed in May 1984, our plan being to demonstrate as much of

the accelerator physics and to develop as much of the technology for the HTE as possible on a relatively small scale. In light of budget constraints, however, emphasis was then shifted to a scaled-down four-beam design, called MBE-4. Its objective is to serve as a proof of principle for the HTE, whereas the technology development must await a larger-scale experiment. MBE-4 will be approximately 12 meters long, but when measured in units of initial pulse length, it is twice as long as the electrostatic portion of the HTE and two-thirds the length of the entire accelerator. It will be injected with 0.2-MeV cesium to study the beam dynamics of 2-MeV sodium in the HTE.

32555 **Resonance due to a local spin rotator in high-energy accelerators.** Lee, S.Y.; Tepikian, S. (Brookhaven National Laboratory, Upton, New York 11973). *Physical Review Letters;* **56**: No. 16, 1635-1638(21 Apr 1986).

A method of solving the spin equation in a large circular accelerator with local spin rotator ("snake") is proposed and compared with a numerical simulation of the spin tracking. We found that (1) the envelope function of the snake structure plays an important role in the spin restoration in passing through the resonance, and (2) a new type of spin depolarization resonance, called snake resonance, appears.

4303 Auxiliaries And Components

REFER ALSO TO CITATION(S) 32153, 32544, 32638, 33261, 33413

32556 **(AD-A—164250/3/XAB) Construction of a high-energy linear accelerator for research in free-electron lasers, beam-wave interactions, spectroscopy, and microcircuitry fabrication. Final report, 1 August 1983-31 July 1984.** Madey, J.M.J.; Yearian, M.R. (Stanford Univ., CA (USA). W.W. Hansen Labs. of Physics). 3 Dec 1985. 12p. NTIS, PC A02/MF A01.

A long-pulse, high-brightness 45-MeV linear accelerator was constructed for use as a driver for free-electron-laser and beam-wave experiments, and as the first section of a 1-GeV injector for a high-brightness electron-storage ring. This contract has led to: 1. demonstration of the highest gradient and longest pulse length yet achieved in a 3-meter S-band SLAC-type travelling-wave accelerator section; and 2. demonstration of the high-current and high current density attainable through the use of a strong microwave field to replace the dc electric field usually used in linac electron guns.

32557 **(DOE/ER/40033—108) UA6 electromagnetic calorimeter: performance and first results.** Snow, G.R. (Rockefeller Univ., New York (USA)). 1985. Contract AC02-81ER40033. 28p. (CONF-8510308—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010233.

From Gas sampling calorimetry workshop; Batavia, IL, USA (31 Oct 1985).

The lead/proportional-tube gas-sampling calorimeter of CERN Experiment UA6 is described. Test beam results are summarized, and our first preliminary physics result - a measurement of inclusive π^0 production in p anti p collisions at $\sqrt{s} = 24.3$ GeV - is presented. 4 refs., 13 figs.

32558 (DOE/ER/40048—102-L4, pp 42) **^{14}N data collection electronics.** Adelberger, E.G.; Hill, N.; Osborne, J.L.; Swanson, H.E.; Zeps, V.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The data acquisition system uses a somewhat modified version of the Laboratory's singles data taking environment along with external electronics to route the Lecroy scalers. Due to the high data rates produced by the photomultiplier tubes, ADC's cannot be used. All events exceeding a lower level threshold are counted in the 100 MHz scalers, and these provide the peak sums used in the analysis. The Laboratory's polarized ion source controller generates the equal period routing sequence and provides the capability of synchronizing the starting and stopping of data acquisition with the transition to a new routing state. In addition, acquisition is inhibited for a preset time around the state transition to allow for transient effects to damp out.

32559 (DOE/ER/40048—102-L4, pp 43) **Data acquisition and analysis programs.** Adelberger, E.G.; Peabody, R.S. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The data acquisition program for the ^{14}N parity mixing experiment provides the master control for the data taking cycle, writes all results on tape and provides an on-line measure of the current and cumulative values of all the transverse and longitudinal asymmetries. A single data acquisition cycle is described. The data analysis program computes the various asymmetries and correlations and makes a statistical analysis of the individual values. By allowing the authors to compare the observed fluctuations of the individual data points with those expected from counting statistics they can determine whether their system is performing as expected.

32560 (DOE/ER/40048—102-L4, pp 44-45) **Design and construction of the ^{14}N parity experiment beamline.** Adelberger, E.G.; Gossett, C.A.; Iqbal, M.Z.; Osborne, J.L.; Swanson, H.E.; Zeps, V.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

As shown in the preceding sections of this report, the measurement of a small (2×10^{-5}) parity non-conserving effect in ^{14}N via the resonant elastic scattering of protons on ^{12}C requires novel designs in the apparatus. The proton counters must cover a large solid angle, yet produce pulses fast enough for the high counting rates. The beam transport system must provide fast automatic stabilization of beam position and angle. The beam line for this experiment must accommodate all of these design considerations while at the same time providing mechanical stability, to reduce asymmetries in the particle counting rates due to translation or vibration of the target chamber, and a clean high vacuum, to reduce carbon buildup on the target.

32561 (DOE/ER/40048—102-L4, pp 45-46) **Studies of system performances using an unpolarized beam.** Adelberger, E.G.; Gossett, C.A.; Osborne, J.L.; Swanson, H.E.; Zeps, V.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The slit and Faraday cup stabilizing feedback loops reduce the error signal by 30 dB and 10 dB, respectively, at low frequencies, while providing feedback control up to several kHz. A removable quartz viewer has been installed at the target position. This has proved to be both an excellent diagnostic tool and a sensitive way for determining the best beam focus. The best beam spots thus far have been ~0.5 mm x 0.5 mm. Collimators have been put on the front counters in order to equalize the rate in the front and back counters. This has allowed the authors to raise the beam current, increasing the rate in the back counters, while maintaining a tolerable rate in the front counters. Because the collimators expose only the central portion of the scintillators to the scattered protons, the resolution in the front counters has improved from ~25% to ~13%. At present the back counters can see protons scattered from further down the beamline, creating a continuum of noise that accounts for ~10% of the total back detector counts. Plans for a cold shroud which should eliminate this problem, are in the shop.

32562 (DOE/ER/40048—102-L4, pp 47) **Fundamental symmetries in atoms: parity mixing in hydrogen and deuterium - introduction.** Trainor, T.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The object of this experimental program is to measure the weak interaction coupling of n=2 s and p states in hydrogen and deuterium via resonant two-photon s-s transitions induced in a fast atomic beam at 570 G. The sensitivity of the experiment remains, as it was reported last year, at about 1000 times the Standard Model prediction. Our efforts in the intervening period have been directed toward three of the four limitations of the apparatus: magnetic field inhomogeneity, background pressure, and stray electric fields. The fourth problem, motional electric fields due to the fast atomic beam, is indirectly improved by better magnetic field homogeneity.

32563 (DOE/ER/40048—102-L4, pp 48) **Cleaning and plating of RF cavities:.** Holmgren, D.W. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The sensitivity of the present H-PNC experiment is limited by the ambient electric field in the RF cavities. As part of the effort to understand and eliminate the stray fields, the authors cleaned, polished and plated the RF cavities. The cavities were reassembled and installed in the apparatus. They have not yet determined whether the ambient electric field has been significantly altered.

32564 (DOE/ER/40048—102-L4, pp 48-50) **Alignment and field scans of the new solenoid.** Trainor, T.A.; Wong, P. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Several years ago the authors manufactured an aluminum solenoid consisting of 20 tape-wound pancakes when it was realized that their wire-wound copper solenoid did not produce a magnetic field of sufficient uniformity to permit an experimental sensitivity to the parameter c/sub 2p/ of order unity, their original design goal. In principle it is possible more easily to produce a precision solenoid with tape-wound pancakes, since jigs can be used to precisely locate the tape on cylindrical forms during the winding process, whereas the wire-wound solenoid is subject to various winding errors as each new layer is wound on the one below. However, in the course of routinely checking the new aluminum pancakes for major faults last year, preparatory to installation, the authors observed that a number of construction defects were present which would make the new solenoid not significantly better than the old. So they undertook a careful measurement program which determined the mechanical, electric and magnetic properties of each pancake.

32565 (DOE/ER/40048—102-L4, pp 50-51) **Control system for a new solenoid.** Wong, P. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Progress is being made on assembling and testing the new solenoid for the H-atom project. The primary components of this solenoid system are 20 pancakes of wound aluminum tape, a 20 channel shunt board which determines the relative amount of current flowing in each pancake and a high performance dual current regulator. One of the major advantages of the new solenoid is that the current through each pancake can be varied individually, allowing variations in B/sub z/ to be minimized. To accomplish this a large PVC board with 20 loops of Nichrome wire has been constructed.

32566 (DOE/ER/40048—102-L4, pp 74-75) **Crossed-beams polarized ion source.** Douglas, J.G.; Gossett, C.A.; Kellogg, S.E.; Trainor, T.A.; Will, D.I.; Zeps, V.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

This ion source was to be produced by ANAC, Ltd. at Auckland, New Zealand. ANAC went into receivership in December, 1982, with work on the project only partially completed. What has been received from ANAC is about 70% of the hardware required to complete the original design. This design calls for a cesium gun, a ground state atomic beam source, an ionizer region, a neutralizer/inflector region and a spin precessor. In addition are required power supplies, racks, support stands, vacuum hardware, and control systems. To date, the ion source parts have been uncrated and assembled to the extent possible in an off-line area. Electrical power and cooling water have been delivered to the site. Cable ways have been designed and installed. Missing power supplies and vacuum hardware have been purchased and delivered. The control software has been completed and delivered. The power and control wiring is being installed. Concurrently a major design effort is in progress. All detailed ANAC designs have been reviewed and significant changes or additions made based on operating experience at this and other laboratories with similar hardware.

32567 (DOE/ER/40048—102-L4, pp 76) **Sputter source elevation.** James, P.; Trainor, T.A.; Will, D.I.; Willis, P. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The elevation of our sputter source to improve beam transmission through our FN tandem, as mentioned in last year's annual report, was largely completed and evaluated in the fall of 1983. The original 25 keV source, its frame and vacuum system, associated isolated power supplies, their rack, deionized cooling water lines, light pipe telemetry, the 100 keV Dowlish accelerating tube, and the 10 kVA isolation transformer have all been tested to 60 keV elevation (for a total injected beam energy of 85 keV.)

32568 (DOE/ER/40048—102-L4, pp 82) **Target preparation.** Hinn, G.M. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

A few of the more interesting of the 210 targets prepared in the Laboratory last year are listed. In addition the author continues to use powdered silver mixed with /sup 9,10/BeO to produce sources for accelerator radio dating of Alaskan and South Polar snow. Currently, he is trying to increase production by multiple sample processing. Also the author routinely makes 3 $\mu g/cm^2$ cracked slacked carbon stripper foils and is continuing research with some degree of success in making enriched ^{28}Si targets starting with the oxide.

32569 (DOE/ER/40048—102-L4, pp 97-98) **Beam dynamics for the UW booster project.** Cramer, J.G.; Storm, D.W. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The beam transport line which injects the booster requires a dogleg isochronous transport system which displaces the tandem output beam from the beam axis of the tandem accelerator to a parallel axis 3.6 m to the south of the tandem axis. This transport must be independent (in first order at a given energy) of the path which a given particle takes through the beam transport system. This preserves the time structure quality of the bunched beam from the tandem. The system employs four 45° magnetic dipole bending elements and two pairs of magnetic quadrupole signlet focusing elements.

32570 (DOE/ER/40048—102-L4, pp 99) **Resonator test facility.** Stowell, R.E.; Swanson, H.E.; Storm, D.W. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Progress on the test facility to date has largely been in the specification and procurement of rf components and test equipment needed for the lab. This facility is required to make measurements of quarter wave resonator (QWR) parameters such as Q and the resonant frequency. It will allow the authors to operate the QWR's both warm and at superconducting temperatures, at power levels simulating LINAC operating conditions. The first low beta prototype resonator was tested at Stony Brook and that experience was useful in writing specifications to obtain the appropriate capability.

32571 (DOE/ER/40048—102-L4, pp 100) **Resonator control system.** Stubbs, C.; Swanson, H.E. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Control of the resonators is to be achieved in a manner similar to that used on the Stony Brook LINAC. The resonant cavity is made to oscillate by making it part of a self-excited feedback loop. The loop consists of an rf amplifier and an electronic module whose phase shift and attenuation can be controlled. Oscillation occurs at the point where the total loop phase shift is a multiple of 360 degrees. If the phase shift external to the resonator differs from 360 degrees, then the resonator must oscillate off resonance to make up for this phase difference. In this manner control is achieved over the frequency of the resonator and it can be locked to the phase of the master oscillator.

32572 (DOE/ER/40048—102-L4, pp 101) **Booster cryogenics.** Storm, D.W.; Weitkamp, W.G.; Will, D.I. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

During this past year the authors have ordered a helium refrigerator, developed cryostat specifications and come to understand better some of the potential problems to avoid in helium distribution systems. The helium refrigerator consists of a Koch Process Systems 2800HR with three type RS screw compressors. The 2800HR has two dry expansion engines, each with two 3" diameter pistons, and one wet expansion engine with a single 2" diameter piston. It has guaranteed capacities at 4.5°K of 440 W without liquid nitrogen precool and of 510 W with liquid nitrogen precool which compare favorably with the estimated need of 300 W. At present the authors have nearly completed material, technique and performance specifications for their cryostats, pending a decision on bayonet design, and the authors are beginning preliminary specifications for their liquid helium distribution manifold and transfer siphons.

32573 (DOE/ER/40048—102-L4, pp 101-102) **Plating laboratory.** Seamster, A.G.; Weitkamp, W.G. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The lead plating of the prototype resonator has been conducted entirely in the plating laboratory at SUNY Stony Brook. Because of the considerable cost and inconvenience in transporting personnel and materials to and from Stony Brook, it is clearly impractical to plate all the resonators there. Furthermore, the high-beta resonator cannot be accommodated at Stony Brook without modifying the set up there. Consequently the authors are constructing a plating lab in-house.

32574 **(IAE—4024/14) Stabilized pulse-width modulation power supplies.** Bel'kov, A.I.; Bryukhanov, A.N.; Kakunov, I.I.; Latushkin, S.T.; Rezvov, V.A.; Yudin, L.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 16p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702042.

A series of current sources and voltage sources created on the base of a type module of power transistors and control, stabilization and protection unit is described. The main element of the series is an output stage performed according to the bridge network and operating in the pulse-width modulation mode. The sources ensure 10^{-3}-10^{-4} stability. The power is controlled from W tens to few KW; current range is 5 mA-100 A, voltage range - 20-80 kV.

32575 **(ITEF—178(1984)) Multipole lenses with implicit poles and with harmonic distribution of current density in a coil.** Skachkov, V.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 40p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86702043.

General theory of the multipole lense with implicit poles is presented. The thickness of lense coil is finite. Current density distribution in the coil cross section is harmonic in the azimuth direction and arbitrary in the radial one. The calculation of yoke contribution in the lense field is given. Two particular lense variants differing from each other in the method of current density radial distribution are considered and necessary calculated relations for the lense with and without yoke are presented. A comparative analysis of physical and technological peculiarities of these lenses is performed.

32576 **(LA-UR—86-934) Additional measurements of the radiation environment at the Los Alamos Spallation Radiation Effects Facility at LAMPF.** Davidson, D.R.; Reedy, R.C.; Greenwood, L.R.; Sommer, W.F.; Wechsler, M.S. (Los Alamos National Lab., NM (USA); Argonne National Lab., IL (USA); Iowa State Univ. of Science and Technology, Ames (USA)). 1986. Contract W-31-109-ENG-38;W-7405-ENG-36. 24p. (CONF-860605—12). NTIS, PC A02/MF A01; GPO Dep. File Number DE86008736.

From 13. international symposium on the effects of radiation on materials; Seattle, WA, USA (23 Jun 1986).

Foil activation dosimetry experiments were conducted in a "rabbit" system at the completed Los Alamos Spallation Radiation Effects Facility (LASREF). The "raffit" system contains four tubes spaced radially outward 0.12, 0.18, 0.27, and 0.38 meters off beam centerline. Foils were irradiated for 3 to 62 hours to measure the neutron flux and energy spectrum radially from beam centerline, along the beamline, and the effect of the Isotope Production (IP) target loadings on the neutron flux in the neutron irradiation locations. Irradiations showed a decrease in the radial flux by a factor of 6 in 0.15 meters of iron outside the IP targets. An enchancement was seen in the 24-keV energy region outside 0.15 meters. There was little difference in the shape of the spectra outside the IP targets and the beam stop with the exception of the high energy tail (energies above 20 MeV). The decrease in the high energy tail outside the beam stop is due to the degradation of the energy of the proton beam in the IP targets. Irradiations outside the beam stop with zero and eight IP targets gave the same spectral shape with the exception of the high energy tail. The magnitude of the integral flux decreased by a factor of 2 when eight IP targets were present. Irradiations with five "rabbits" stacked on top of each other showed no difference in the integral flux below, on and above beam centerline.

32577 (LBL—19100, pp 9-13) **Accelerator development activities.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

Accelerator developments are aimed at more efficient use of operating time, higher beam intensities, and a greater variety of available ions. Completion of the local injector upgrade will be a major step toward the first of these goals. The objective is to allow effectively simultaneous use of beam time by the nuclear science and biomedical programs at the Bevalac. (As an added benefit, much that was learned during the local injector project is now being applied in the development of a radio-frequency quadrupole preinjector for CERN). A second major upgrade, centered around a unique ion source design, will increase by tenfold the available intensity of uranium beams at the Bevalac. At the SuperHILAC, detector and rf system improvements proceeded on schedule.

32578 (LBL—19100, pp 16-20) **Superconducting magnets.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

Development of 1-meter-long model magnets continued in 1984. Prototypes with 50-mm bores reached new record fields for accelerator-type magnets: 9.1 T for Nb-Ti-wound models and 8.1 T for Nb_3Sn (at 1.8 and 4.4 K, respectively). Increasing attention, however, turned to SSC-related activities. We continued to develop our proposed 6.5-T design by successfully testing four 1-meter models to the design field strength. In a related effort, a team led by LBL demonstrated significant improvements in attainable critical current densities for Nb-Ti; at 5 T the SSC specification of 2400 A/mm^2 was readily exceeded. Along similar lines, superconducting cable development was highlighted by construction of a cabling machine that provides great flexibility in cable parameter selection and by investigations of unconventional cable configurations.

32579 (LBL—19100, pp 61-62) **Synchrotron radiation projects.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

X-ray optical techniques are currently being applied in several important synchrotron beamline projects. These projects involve powerful wigglers (at the Stanford Synchrotron Radiation Laboratory, SSRL), high-coherent-power undulators (at Brookhaven National Laboratory), components under intense thermal loading, and sophisticated x-ray optical systems designed to reduce aberrations and improve spectral resolution. These projects are important to the synchrotron community as a whole, not only because of the new high-flux experimental opportunities they offer, but also

because they help to secure a technological base for the next generation of storage-ring photon sources.

32580 (LBL—19100, pp 62-63) **Permanent-magnet structures.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

Periodic permanent-magnet structures are at the heart of many future radiation sources. These include sources of both coherent and incoherent radiation - wigglers, undulators, several approaches to free-electron lasing, and transverse optical klystrons. Important issues include controlling field errors, achieving strong fields at moderate cost, and coping with the details of fringe field control. Among our many studies and design projects, several stand out: the Livermore wiggler project for Beamline VIII at SSRL, a collaboration with AT & T Bell Laboratories to study the effects of field errors in long undulators, the design of a microwave FEL undulator to be used at Livermore, and the design of a crossed undulator pair for polarization control at NSLS.

32581 (LBL—19100, pp 66-68) **Coherent XUV facility.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

The availability of coherent radiation sources in the vacuum ultraviolet and soft x-ray regions of the spectrum depends on advances in insertion device technology and on the design of storage rings to exploit these advances. In particular, if ultraviolet and x-ray FELs are to become practical, a moderate-energy ring must be available that is capable of storing electron beams of high current and very low emittance. Such a ring could, in addition, serve as a test bed for other advanced concepts, such as crossed undulators and transverse optical klystrons. Our efforts to design such a ring, which we call the Coherent XUV Facility, had just begun at the end of fiscal 1984, but a preliminary parametric study was completed by the end of the fall and is summarized below.

32582 **(SAND—86-0469) Hydramite II screening tests of potential bremsstrahlung converter debris shield materials.** Reedy, E.D. Jr.; Hedemann, M.A.; Stark, M.A. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1986. Contract AC04-76DP00789. 28p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010306.

Results of a brief test series aimed at screening a number of potential bremsstrahlung converter debris shield materials are reported. These tests were run on Sandia National Laboratories' Hydramite II accelerator using a diode configuration which produces a pinched electron beam. The materials tested include: (1) laminated Kevlar 49/polyester and E-glass/polyester composites, (2) a low density laminated Kevlar 49 composite, and (3) two types of through-the-thickness reinforced Kevlar 49 composites. As expected, tests using laminated Kevlar 49/polyester shields showed that shield permanent set (i.e., permanent deflection) increased with increasing tantalum conversion foil thickness and decreased with increasing shield thickness. The through-the-thickness reinforced composites developed localized, but severe, back surface damage. The laminated composites displayed little back surface damage, although extensive internal matrix cracking and ply delaminations were generated. Roughly the same degree of permanent set was produced in shields made from the low density Kevlar 49 composite and the Kevlar 49/polyester. The E-glass reinforced shields exhibited relatively low levels of permanent set.

32583 **Development of a multicusp H^- ion source for accelerator applications.** York, R.L.; Steven, R.R. Jr. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 410-417(1 Mar 1984). (CONF-831180—).

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

The development of a multicusp surface-production H^- ion source (Berkeley concept) designed specifically for accelerator use is described. The goal of this development effort has been to provide a suitable H^- ion source for the Proton Storage Ring now being constructed at LAMPF. The ion source that has been developed is now capable of long-term operation at 20 mA of H^- current at 10% duty factor and with normalized beam emittance of 0.13 cm-mrad (95% beam fraction). The development program will be described with particular emphasis on beam emittance measurements.

32584 **Optically pumped polarized H^- ion source.** Mori, Y.; Ikegami, K.; Takagi, A.; Igarashi, Z.; Fukumoto, S.; Cornelius, W.; York, R. (National Laboratory for High Energy Physics, Los Alamos National Laboratory). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 769-778(1 Mar 1984). (CONF-831180—).

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

Optically pumped polarized H^- ion source has been developed for the 12 GeV proton synchrotron at KEK. Sodium atoms are electron-spin polarized by two single frequency dye lasers. Protons, which are yielded by an ECR ion source, receive the polarized electrons from the sodium atoms and are polarized by conventional zero-crossing method. The hydrogen atoms become H^- ions by charge-exchange reaction with sodium vapor. Beam intensities and polarizations so far achieved are 15 μA with 60 % and 25 μA with 40 % at 350 keV. The intensity increases recently to 30 μA and the beam is accelerated to 20 MeV by the linac and injected in the 500 MeV booster synchrotron. The polarization is 45~56 % at 20 MeV.

32585 **Operating experience with a 100-keV, 100-mA H^- injector.** Allison, P.; Sherman, J.D. (AT-2 Los Alamos National Laboratory, Los Alamos, NM 87545). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 511-519(1 Mar 1984). (CONF-831180—).

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

According to beam dynamics calculations it should be possible to accelerate a high-perveance beam in a radio-frequency quadrupole (RFQ) accelerator with low emittance growth and nearly 100% capture efficiency. A 100-mA, 100-keV H^- ion injector with a 5-Hz, 1-ms duty factor was built for use with this accelerator, but the beam emittance at 100 keV was found to be two to four times the value previously determined at 20 keV. This emittance growth was traced to the 20-keV beam transport, where an instability occurred in the background plasma created by beam ionization of the residual gas. The injector has been rebuilt with a shorter transport length, resulting in greatly reduced emittance growth.

32586 **End effects in slot extraction for a SITEX negative ion source.** McGaffey, R.W.; Meszaros, P.S.; Wealton, J.H.; Raridon, R.J.; McCollough, D.H. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 533-546(1 Mar 1984). (CONF-831180—). Contract W-7405-ENG-26.

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

A 3D solution to the Poisson Vlasov equation of the form del²phi = ∫fdv-e⁻/sup phi/ (1) (v x B+delphi) x del/sub v/ f+v x delf = 0 (2) is obtained in the extraction region using the technique of Ref. 1. A constant magnetic field B is imposed. Algorithms designed to solve the above equations were modified to include the curved emitter boundary data appropriate to a negative ion source. The end of the slot was optimized to minimize aberrations.

32587 **Photodetachment technology.** Fink, J.H. (Lawrence Livermore National Laboratory, Livermore, CA 94550). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 547-560(1 Mar 1984). (CONF-831180—). Contract W-7405-ENG-48.

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

This report gives an analysis of a neutral beam line formed of negative ions and stripped in a photoneutralizer. Estimates are made of its performance when neutralized by an atomic-iodine laser.

4304 Storage Rings

REFER ALSO TO CITATION(S) 32547

32588 **(DESY—85-139) On multi-bunch instabilities for fractionally filled rings.** Kohaupt, R.D. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Dec 1985. 7p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751742.

In the case of a "symmetric" filling of possible buckets in the ring the solution of multi-bunch motion driven by parasitic cavity modes can be described in terms of "normal modes" of the bunch system. The growth rates for the normal modes are then explicitly related to "families" of parasitic modes. For arbitrary fractional fillings of the ring, however, the system cannot be solved explicitly and the relation between "mode" growth rates and parasitic cavity modes becomes rather complicated. Thus, the important question arises, whether growth rates for fractional fillings can be related to those for symmetric fillings. Another important question is connected with the necessary bandwidth for a damper system: If for a symmetric filling only a few modes are unstable, one can design a damper system operating only in that (restricted) frequency range corresponding to the frequency range of the unstable modes. Is such a damper system then sufficient to damp the multi-bunch instabilities also in a fractional filling. It is shown in this note that the growth rates of a fractional filling can be related to the growth rates of the symmetric filling. Any damper system keeping a symmetric multi-bunch filling stable also suffices to damp instabilities in a fractional filling. (orig.).

32589 **(DOE/ER/40142—1) anti pp options for the supercollider: proceedings.** Pilcher, J.E.; White, A.R. (eds.). (Argonne National Lab., IL (USA); Chicago Univ., IL (USA)). Feb 1984. Contract FG02-84ER40142. 400p. (CONF-840275—). NTIS, PC A17/MF A01; 1; GPO Dep. File Number DE85010203.

From Workshop on anti pp options for the SSC; Chicago, IL, USA (13 Feb 1984).

Separate abstracts were prepared for 35 papers in these workshop proceedings. Twelve other papers in these proceedings have been previously abstracted for EDB. (LEW)

32590 **(FNAL-TM—1395) Studies of beam induced radiation for experiment 735 at the CO interaction region and its effect on detector components.** Turkot, F.; Hojvat, C.; Anderson, W.; Lindsey, C.S.; Biswas, N.; Piekarz, J.; Bujak, A. (Fermi National Accelerator Lab., Batavia, IL (USA)). 12 Jun 1985. Contract AC02-76CH03000. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010594.

A series of measurement is reported that were conducted to evaluate the amount of radiation present in the Fermilab Collider tunnel under different circumstances. Also to be determined is the effect of radiation on scintillators, phototubes, and their electronics, possible damage to drift chamber wires due to high counting rates and possible damage to the drift chamber electronics. Background and resulting trigger rates are evaluated and the effect of local shielding is studied. Results of radiation measurements made during beam-on operation are presented. The detectors used include: two arrays of LiF crystal dosemeters, three scintillation counter telescopes, a modified ion chamber, and six sample pieces of Bicron plastic scintillators. (LEW)

44 INSTRUMENTATION

4401 Radiation Instrumentation

REFER ALSO TO CITATION(S) 31873, 32233, 32330, 32557, 32558, 32559, 33093, 33099, 33232, 33234, 33341, 33342, 33343

32591 **(AD-A—164091/1/XAB) Response of ideal photodetectors to photon flux and/or energy flux.** Bondurant, R.S. (Massachusetts Inst. of Tech., Lexington (USA). Lincoln Lab.). Nov 1985. 7p. (JA—5702). NTIS, PC A02/MF A01.

A theory of photoelectron counting is presented that combines the perturbation-theory approach of Glauber with the damped-field model of Mollow. It is shown that, to first order in field-spectral bandwidth, broadband photodetectors respond to photon flux rather than power. By phenomenologically including the effect of the detector on the field, the drawbacks and inconsistencies which limit the validity of traditional perturbative calculations to cases of very low quantum efficiency are eliminated.

32592 **(CEA-N—2457) Study to measure νsub(μ)-e scattering with a water Cherenkov detector.** Candelle, J.M. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Nov 1985. 134p. (In French). NTIS (US Sales Only), PC A07/MF A01. File Number DE86751814.

A new technique is proposed to study the elastic diffusion νsub(μ)e. This technique consists in collecting the Cherenkov light created by the charged particles in a water tank. This method was tested at CERN, with electron, muon, pion, and gamma beams. The aim of the test was to know if it is possible to measure precisely the diffusion angle of electrons with a good electron-hadron, and electron-gamma discrimination. We obtained a very good angular resolution, close to 6 mrd$\sqrt{E(GeV)}$. The hadronic rejection rate is close to 10^{-3}. The electron-gamma discrimination is less clear; for an electron acceptance of 80%, the gamma rejection factor is equal to 5. Furthermore, the data are consistent with the number of 50 photo-electrons emitted in the water by centimeter. This technique could be used to measure sin²thetasub(w) with an absolute precision of 0.005.

32593 **(CONF-8405192—3) Scintillation neutron detectors.** Davidson, J.B. (Oak Ridge National Lab., TN (USA)). 1984. Contract AC05-84OR21400. 8p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010403.

From Workshop on instrumentation for the advanced high flux reactor; Oak Ridge, TN, USA (30 May 1984).

Two basic types of scintillation area neutron detectors are reviewed. The first is the prompt detector which uses photomultipliers to convert the neutron scintillations to electrical pulses. These signals are combined in weighting or encoding circuits to give event location. Several embodiments of the weighted and coded scintillator approach are mentioned. The second type of scintillation detector is based on television techniques and has a delayed readout. In this method all the light (or as much as possible) is either focused with a fast lens or is coupled by being put in direct contact with the fiber-optic faceplate of an image intensifier tube. The light from the phosphor screen is intensified and coupled to a television camera tube instead of a photomultiplier, and further amplification is produced in the camera tube by accelerating the photoelectrons in order to produce secondary electrons. (LEW)

32594 (DOE/ER/40048—102-L4, pp 39-40) **High count rate-low energy proton detectors.** Adelberger, E.G.; Murphy, M.J.; Osborne, J.L.; Swanson, H.E.; Zeps, V.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

In order to measure a small parity violating effect, the authors need to count ~1 MeV protons at high rates. Several requirements determined the proton detection scheme: a) a large solid angle coverage with relative insensitivity to small beam position and angle fluctuations, i.e., large detectors at large distances, b) short pulse width, c) good energy resolution and, d) low back-

ground noise. The method chosen was to mount thin (50 μm) scintillators on 5-cm diameter photomultiplier tubes (PMT's). The design and fabrication of these detectors is described.

32595 (DOE/ER/40048—102-L4, pp 78) **Construction and testing of a Breskin counter.** Leach, D.D. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

A Breskin type multiwire proportional chamber of 2 x 2 cm has been built and successfully tested. This counter uses two aluminized hostaphan foils operated at ground potential and separated by 6 mm. Midway between these two foils is a harp of 20 μm gold-plated tungsten wires on 1 mm centers. These wires are all connected to a common bus. During operation 1-2 Torr of P-10 gas was circulated through the counter and +490 V was applied to the wire harp. The harp signal was amplified with a fast preamp and fed into a constant fraction discriminator. This signal was compared to a signal from a silicon surface barrier E detector. Time resolutions of 220 psec and 240 psec were recorded for 68 MeV ^{16}O and 95 MeV Br respectively.

32596 (DOE/ER/40048—102-L4, pp 78-79) **Use of the LED-PIN diode light pulser for gain stabilization of the 10″ x 10″ NaI spectrometer.** Dowell, D.H.; Gossett, C.A.; Snover, K.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The authors have recently begun routine use of an LED-PIN diode light pulser system for gain stabilization of the NaI spectrometer. The designs of the LED driver circuit and LED stabilization are described in an earlier annual report. A special optical fanout bundle is used to couple a single LED to the seven photomultiplier tubes on the NaI detector. The tubes are back-illuminated by shining the LED light through the glass wall onto the rear of the photocathode, and with proper matching of the optical couplings, the light is uniformly distributed among the phototubes. The couplings of the LED to the fiber bundle and to the PIN diode are balanced in such a way as to allow for a good signal-to-noise ratio in the PIN signal, while operating the LED over a wide dynamic range up to effective gamma-ray energies well above 50 MeV. The authors experience with the gain stabilization system over the past few months indicates that the long term regulated stability of the NaI is better than 0.5%. In addition, no short term gain shifts are observed associated with varying detector rates in the range from 2 to 160 kHz, leading also to upper limits of 0.5%.

32597 (DOE/ER/40048—102-L4, pp 79-80) **Improvement and testing of the momentum filter.** Amsbaugh, J.F.; Davis, K.J.; Murakami, T.; Storm, D.W. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

During the past year the authors have made a number of modifications which permit easier and more reliable operation of the momentum filter. Leaks in two welded bellows in the quadrupole vacuum ducts were discovered and sealed. The authors also had to replace the cryopump on the scattering chamber. In addition they devised a technique for mounting the Bragg Curve Spectrometer (BCS) at the final focus without significantly affecting the vacuum throughout the rest of the system. With the scattering chamber open to the beamline and the BCS mounted and operating the authors were able to maintain a vacuum of 1×10^{-6} Torr in the scattering chamber, 1×10^{-7} Torr at the dispersed focus and 8×10^{-7} Torr at the final focus. By running a particle beam directly into the momentum filter the authors were able to determine ray trajectories at the dispersed focus by measuring currents on moveable pins and at the final focus by measuring beam positions on a plastic scintillator. These measurements confirm previous findings that the foci are down-stream of their predicted positions. This situation can be corrected somewhat by reducing the quadrupole currents by between 10 and 15%.

32598 (DOE/ER/40048—102-L4, pp 81) **Polarimeter for the momentum filter.** Christensen, C.R.; Murakami, T.; Weitkamp, W.G. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Testing the proton polarimeter for use with the momentum filter described in last year's Annual Report has continued. The polarimeter uses elastic scattering from ^4He with vanes to restrict scattering to angles centered around 60°. The detectors are 114 by 6.4 mm disks of NE 102 plastic scintillator viewed by photomultipliers. The authors have found that the plastic scintillators are too sensitive to neutrons. A small proportional counter has been installed in front of the polarimeter so they can use coincidence between this counter and the scintillators to reduce neutron induced background. The focal properties of the momentum filter appropriate to the polarimeter have also been measured.

32599 (DOE/ER/40048—102-L4, pp 83-84) **Data acquisition system enhancements.** Adelberger, E.G.; Peabody, R.S.; Seymour, R.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The principal data acquisition system consists of a DEC PDP 11/60 computer with two 5 megabyte RL-01 disks, a 1600 bpi 75 ips 9 track tape drive, a Printronix P-300 printer/plotter with a Trilog Tektronix hardcopy board, a DEC VT-11 graphics display, a Tektronix 4006 terminal and a BiRa MBD-11 controlling a CAMAC crate to connect with twelve Tracor Northern TN-1213 ADCs. 15 NPL-built 75 MHz scalers are read via an IEEE-488 bus interface. New data acquisition hardware and software are described and some programming considerations are discussed.

32600 (DOE/ER/40048—102-L4, pp 85-86) **Data analysis system enhancements.** Adelberger, E.G.; Garman, E.F.; Harakeh, M.N.; Lazzarini, A.; Murphy, M.J.; Peabody, R.S.; Patterson, D.A.; Seymour, R.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The data analysis system consists of a DEC VAX 11/780 with dual RK-07 disks, a SI Eagle disk, three 9 track and one 7 track tape drives on Western Peripheral controllers, a Printronix P-300 printer/plotter and an AED-512 color graphics display. Several hardware and software developments are described.

32601 (DOE/ER/40048—102-L4, pp 87) **Hardware enhancements to the laboratory data collection system.** Seymour, R.J.; Stowell, R.E.; Van Wechel, T.D. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The core of the laboratory data collection system consists of 12 commercial Tracor Northern 200 MHz ADC's interfaced to a DEC PDP 11/60 computer. The operation of this system has been described in detail in earlier annual reports but is summarized. Enhancement of this data collection hardware consisted of redesigning and constructing a new chassis for the ADC computer interface. This was done to: (1) increase reliability of the system, (2) incorporate all the changes that have occurred over the past four years, (3) provide a system that would allow in-rack diagnosis and board swap repairs, and (4) provide extra room and connector and mode switch capacity for future expansion.

32602 **(FEI—1604) Monte-Carlo calculation of the response function of the big scintillation detector for neutron capture detection.** Androsenko, P.A.; Bolonkina, G.V.; Kononov, V.N.; Poletaev, E.D.; Timokhov, V.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1984. 14p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702077.

Technique for calculation of the response function of a large liquid scintillation detector of radiation capture events is described. The GAMBAK and CYLIND programs permittinq to calculate γ-radiation energy losses in the sample and scintillator under the conditions of real geometry and a complex multicascade source usino the Monte-Carlo method are described in brief. The results of the calculations are compared with experimental amplitude detector spectra. The developed technique permits to calculate efficiency of a real detector at zero threshold as well as to obtain the correction

for the ratio of the spectrum lying above the threshold. This technique permits also to determine corrections to self-absorption of capture γ-rays in samples.

32603 **(IFVE-OEF—85-91) Data processing on the boundaries of the GAMS-type electromagnetic calorimeter.** Vasil'ev, A.N.; Matulenko, Yu.A.; Nurushev, S.B.; Solov'yanov, V.L. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). 1985. 7p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702078.

Algorithm of recovering energy and coordinate of γ-quantum interacting in the GAMS type calorimeter near its boundary is described. Special measurements are conducted on a 26 GeV electron beam for finding a mathematical expression of the form of electromagnetic shower. A proportional chamber has been used for determination of the coordinate of electron input to the calorimeter. Distribution of the form of electromagnetic shower was determined by processing 200000 of events. The distribution was smoothened and tabulated. Dependence of the form of shower was not taken into account. Part of electron energy released in the given counter can be determined from the table as a function of x and y coordinates of the counter centre relatively to the point of γ-quantum hitting the calorimeter.

32604 **(IPEN-Pub—80) Radon detection in soils by solid state nuclear track detectors.** Moraes, M.A.P.V. de; Khouri, M.T.F.C. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702076.

The solid state nuclear track detector technique was developed to be used in radon detection, by alpha particles tracks, and has been applied in uranium prospecting on the ground. The sensitive films to alpha particles used were the cellulose nitrate films LR 115 and CA 8015. Several simulation experiments and field measurements were carried out to varify the possibilities of the method. Maps of some anomalies in Caetite City (Bahia, Brazil) were made with the densities of tracks obtained. The results were compared with scintillation counter measurements.

32605 **(ITEF—13(1985)) Electrodynamic spark chamber calculational model.** Bolonkin, B.V.; Nozdrachev, V.N.; Sokolovskij, V.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 17p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702079.

A calculational model of a wire spark chamber with the electrodynamic data read-out is considered. The model was developed for providing a required accuracy of the point determination on a track and takes account of geometric characteristics of each of 64 chambers of a magnetic spectrometer, sound duct material properties, mechanism of spark development and electronic properties. The model permits to adequately describe tracks with an angle of up to 0.5 rad. between a tangent to the track and a normal to chamber electrodes. The requirement of periodical changing of direction of ultrasonic pulse propagation, which permits to determine the effect of a current pulse shape in sparks and delays of their development with respect to reference pulses is introduced into the model. The model also permits to attain track coordinate mesurement accuracy better than 0.4 mm for 0.5-40 GeV/c particle pulses. This allows to determine particle pulse passing through all the spectrometer chambers with 0.5% accuracy and the effective mass of $\pi^+\pi^-$ meson track pairs of K^0 decay with an error of an order of 10 MeV/c.

32606 **(JINR—D-1-85-166) Operation of plastic streamer tubes with high resistive coating.** Golovatyuk, V.M.; Guzik, Z.; Zimin, N.I.; Kadyrov, R.B.; Nigmanov, T.S.; Ryabtsov, V.D.; Sadovskij, A.B.; Tyapkin, I.A.; Filatova, N.A.; Tsyganov, Eh.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1985. 4p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702080.

Submitted to the journal Nucl. Instrum. Methods.

Operation stability of plastic streamer tubes is an important condition for providing hadron calorimeter reliability. Causes of the detector failure were investigated using 9x9 mm cross-section profiles. 105 μm diameter silvered wire of beryllium bronze was used as anode: gas mixture composition-argon-isobutane with 1:3 ratio. Effect of carbon coated cathode resistance on the wire chamber operation stability has been studied. It is shown that at the cathode resistance of higher than 90 kOhm per a square the detector operation in the self-quenching mode becomes unstable.

32607 **(KFK—3988-B) Gas-silicon telescope for medium-heavy ion detection.** Kozik, T.; Buschmann, J.; Neudold, M. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Kernphysik). Dec 1985. 25p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751753.

A ΔE-E telescope for the identification of medium-heavy ions is presented. The specific energy loss is measured with a gas ionization chamber, and the residual energy is determined with a silicon surface barrier detector. The main features of the collecting electrical field and the timing properties of the device are discussed under theoretical aspects. The gas supply system, its electronic control unit, and the operating procedures are described. Two different versions of the coincidence electronics are shown. The experimental performance of the gas-silicon telescope is demonstrated and is found to be close to the best Z-resolution which can be obtained with this technique. (orig.).

32608 (PNL-SA—13346, pp 4-17) **Concept of secondary laboratories.** Eisenhower, E.H. (National Bureau of Standards, Gaithersburg, MD). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The purpose of this Workshop is to discuss possible future national programs in two related areas of interest. First is a possible radiation survey instrument testing program, based on a national performance standard under development. Second is the establishment of a system of secondary laboratories that could provide instrument calibrations and related services. Those services could include, for example, instrument performance testing. The general characteristics and operational concepts of the secondary laboratories are considered.

32609 (PNL-SA—13346, pp 30-38) **Need for quality dose measurements.** Forbes, J.L. (American Nuclear Insurers, Farmington, CT). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

Work procedures based upon dependable measurements have unquestionably reduced past exposures to a level that will produce few injuries in later years. Of the many legal issues that might be discussed with regard to instrument calibration, the two of present concern are the determination of cause, and the evidence (including expert testimony) submitted to that end. Although they are termed here legal issues, they are in fact highly technical problems which have recently become political footballs. Some background is discussed in order to understand how such legal/technical/political considerations are related to instrument calibration, the subject of this workshop.

32610 (PNL-SA—13346, pp A.3-A.20) **Problems with radiological surveillance instrumentation.** Swinth, K.L.; Tanner, J.E.; Fleming, D.M. (Pacific Northwest Lab., Richland, WA). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

Many radiological surveillance instruments are in use at DOE facilities throughout the country. These instruments are an essential part of all health physics programs, and poor instrument performance can increase program costs or compromise program effectiveness. Generic data from simple tests on newly purchased instruments shows that many instruments will not meet requirements due to manufacturing defects. In other cases, lack of consideration of instrument use has resulted in poor acceptance of instruments

and poor reliability. The performance of instruments is highly variable for electronic and mechanical performance, radiation response, susceptibility to interferences and response to environmental factors. Poor instrument performance in these areas can lead to errors or poor accuracy in measurements.

32611 (PNL-SA—13346, pp A.21-A.39) **Radiation survey instruments: the power reactor perspective.** Flanigan, J. (GPU Nuclear Corp., Middletown, PA). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

This study was initiated to evaluate the current state-of-the-art of radiation survey instruments in the power reactor environment and to compare today's user's comments to a similar study conducted in 1977. In addition, user input was solicited as to the impact of the proposed ANSI Standard N42.17 on the quality of radiation survey instruments. The limited response (19 of 93) received to date, however, yields a study with limited value. The information contained in this study reflects the input of the respondents and does not necessarily reflect the views of GPU Nuclear Corporation or the author.

32612 (PNL-SA—13346, pp A.40-A.47) **Operational problems with radiation survey instruments: the medical perspective.** Masse, F. (Massachusetts Institute of Technology, Middletown, PA). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

A summary of the special problems and issues related to the use, interpretation, and calibration of radiation survey instruments by the medical profession is presented. A system for placing the responsibility for initial performance and calibration on the manufacturer is proposed. It is suggested that continuing quality control and subsequent calibrations may be readily handled by the user once the initial performance and calibration issue is resolved.

32613 (PNL-SA—13346, pp A.48-A.58) **Operational problems with radiation survey meters: the university and accelerator perspectives.** McCall, R.C. (Stanford Univ., CA). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

This article describes problems encountered with commercial survey meters. The desired qualities of such instruments for use around accelerators are listed. Attempts to meet the accelerator monitoring needs by modifying commercial instruments and by in-house research and development are described.

32614 (PNL-SA—13346, pp B.3-B.11) **Regulatory perspective of operational problems with health physics survey instrumentation.** Federline, M.V.; Alexander, R.E. (Nuclear Regulatory Commission, Washington, DC). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The proper operation and performance of radiation survey instruments are emphasized in this NRC report. Radiation measurements made by regulators and licensees must agree to avoid possible conflicts regarding compliance with regulatory requirements. The authors briefly review some significant problems which may exist in the design and construction of portable health physics survey instruments. They suggest a regulatory program for dealing with health physics instrument performance if a voluntary solution is not initiated.

32615 (PNL-SA—13346, pp B.12-B.18) **Reflective perspectives on [radiation monitors].** Yoder, R.E. (Rockwell International, Golden, CO). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

There is a need to provide to the radiation industry quality, reliable radiation detecting instruments. There is a need to provide an overall assessment of instrument performance under standard conditions but one must not overlook the importance of a qualified health physicist to assure the proper instrument selection for a measurement and the correct interpretation of the readings or data accumulated. Innovation in problem areas must be fostered to achieve advances in dosimetry, radiation measurements, and radiation control.

32616 (PNL-SA—13346, pp B.19-B.23) **State perspective of operational problems related to radiation survey instruments and calibrations.** Craig, R.L. (Oklahoma State Dept. of Health, Oklahoma City). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

A brief look at the instrumentation performance and calibration problems faced by individual state radiation protection agencies is presented. Among other things, the author suggests that a formalized process for establishing traceability of a calibration to a national standard, and a performance standard for both field and laboratory instrumentation be initiated.

32617 (PNL-SA—13346, pp C.6-C.16) **Draft American National Standard N42.17A: performance specifications for health physics instrumentation.** Selby, J.M. (Pacific Northwest Lab., Richland, WA). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The purpose of this report is: (1) to describe what the author sees as part of the driving force in the development of the N42.17 standard on instrument performance, (2) to give a basic description of the standard itself - what it should do and what it should not do - and its relationship to other standards, and (3) to talk about ways the standard might be used on either a voluntary or semi-voluntary basis.

32618 (PNL-SA—13346, pp C.17-C.65) **Evaluation of draft ANSI Standard N42.17 by testing.** Swinth, K.L.; Kenoyer, J.L. (Pacific Northwest Lab., Richland, WA). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

Although limited guidance for the performance of health physics instrumentation exists, there is no broad specification of performance requirements. Draft ANSI Standard N42.17, Performance Specifications for Health Physics Instrumentation, seeks to rectify this by providing a standard with a broad category of performance requirements and evaluation procedures. The third draft of this standard is currently being evaluated by Pacific Northwest Laboratory (PNL). Objectives of the PNL study are to evaluate the applicability and practicality of the proposed standard and to determine the degree of conformance of a cross section of currently available commercial instruments to the proposed standard. This paper presents results of performance tests on ionization chambers, Geiger-Mueller (GM) detectors, and alpha survey meters, plus some information on neutron rem-meters. The instruments used in the testing were loaned to PNL by instrument vendors and users or were purchased directly. The instruments were submitted to a broad range of tests.

32619 (PNL-SA—13346, pp C.66-C.76) **Possible solutions to operational problems: the DOE perspective.** Vallario, E.J. (Dept. of Energy, Washington, DC). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The Department of Energy is focusing on instrument, bioassay, and dosimetry upgrade. They are doing so partly in response to proposed new standards, certification/accreditation programs, litigations, and compensation-related legislation. The DOE will fund research for technology upgrade in the future, but with a shift

in the way funding is approved. In the future, proposals will include design parameters as well as project objectives.

32620 (PNL-SA—13346, pp C.77-C.87) **Possible solution of operational problems: the NRC:ORPB perspective.** Federline, M.V.; Alexander, R.E. (Nuclear Regulatory Commission, Washington, DC). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

An important aspect of an acceptable radiation protection program is acquiring and using appropriate instruments suitable for the field conditions in which they will be used. Design limitations or manufacturing faults may not be detected due to incomplete or inadequate acceptance testing programs and lack of data on field evaluation of large numbers of commercially available health physics instruments. Under such circumstances, procured instruments may fail or perform marginally under routine operating conditions. Because acceptance testing now is incomplete or inadequate and there is no indication that this situation will change, the NRC Occupational Radiation Protection Branch (ORPB) perceives a need to initiate a regional or national program to test and evaluate health physics instrumentation against a consensus standard. Such a program would avoid the case where procured instruments do not pass acceptance tests but cannot be returned to the vendor for repair or replacement.

32621 (PNL-SA—13346, pp C.88-C.95) **Department of Defense perspective.** Devine, R. (Defense Nuclear Agency, Washington, DC). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

This paper examines radiation instrumentation from the Department of Defense perspective. Radiation survey instruments and calibration, or RADIAC, as it is called in the services, while administratively falling under the Assistant Secretary of Defense for Atomic Energy, has generally been managed at a lower level. The Naval Electronics Systems Command and Army Signal Corp are the two principles in the Department of Defense for RADIAC. The actions of the services are coordinated through the tri-service RADIAC working group, which meets about every year and a half. Several points from this organization are highlighted.

32622 (PNL-SA—13346, pp C.96-C.105) **State perspective on radiation instrumentation.** Neuweg, M. (Illinois Dept. of Nuclear Safety, Springfield). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

A discussion of one state's involvement in the certification and calibration of radiation instrumentation is presented in this paper. Illinois cooperated with the National Bureau of Standards to develop a regional state operated instrument calibration center. Their errors involved in the calibration of their instruments are examined. The author would like to see the Calibration Center expand to perform limited performance tests and evaluation in accordance with the proposed ANSI standard. The Conference of Radiation Control Program Directors, Inc. is described. It consists of the program director from each state, their professional and technical staff members within each state radiation control program and representatives of the various federal agencies dealing in radiation matters.

32623 (PNL-SA—13346, pp C.106-C.121) **Manufacturers perspective on radiation instrumentation.** Sinclair, K.F. (Xetex, Inc., Mountain View, CA). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

This paper presents some of the background that relates to the manufacturers perspective on the problems of radiation instrumentation performance and standards. To provide that background, some understanding of the market place and the nuclear instrument manufacturing community is discussed. After touching on those two areas, the author reviews the current and the proposed new approach to satisfying instrument requirements and assesses the impact of the new approach. The author concludes with some specific comments on Draft American National Standards Institute (ANSI) N42.17 and summary comments.

32624 (PNL-SA—13346, pp D.1-D.10) **Secondary standards laboratories: an overview.** Eisenhower, E.H. (National Bureau of Standards, Gaithersburg, MD). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

This paper examines the possible functions of secondary laboratories. The calibration function of the secondary laboratories is outlined, and the interactive Measurement Quality Assurance (MQA) Program is described. Furthermore, accreditation programs for secondary laboratories and dosimetry calibration labs are outlined.

32625 (PNL-SA—13346, pp D.11-D.21) **AAPM accredited dosimetry calibration laboratories.** Loevinger, R. (National Bureau of Standards, Gaithersburg, MD). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The American Association of physicists in Medicine (AAPM) is a national organization that, among its 2000 members, includes essentially all the medical physicists in the United States. It holds national meetings twice yearly and has numerous committees and task groups that are concerned with many aspects of the application of physics to medicine. One of these task groups is responsible for the five dosimetry calibration laboratories that have been accredited by the AAPM. The development and the operation of this group of dosimetry calibration laboratories is the subject of this paper. Those details that may be of interest in considering an analogous system for protection-level calibration laboratories are stressed.

32626 (PNL-SA—13346, pp D.22-D.39) **Implementation of CRCPD accreditation criteria in state calibration laboratories.** Heaton, H.T. II. (National Bureau of Standards, Gaithersburg, MD). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

This paper summarizes the unique aspects of the four state laboratories for calibrating ionizing radiation instruments, with which NBS is presently cooperating. The general requirements of the accreditation criteria developed by the Conference of Radiation Control Program Directors, Inc. (CRCPD) are reviewed and the procedures by which the state labs meet the criteria are discussed.

32627 (PNL-SA—13346, pp D.40-D.51) **Ionizing radiation laboratory of the Center for Devices and Radiological Health.** Ohlhaber, T.R. (Center for Devices and Radiological Health, Rockville, MD). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The Center for Devices and Radiological Health (CDRH) was established within Food and Drug Administration (FDA) in 1983 by combining the Bureau of Radiological Health and the Bureau of Medical Devices. Under this reorganization, the calibration and measurement programs which were initiated in 1966 have been continued. Included in these programs are the instrument calibration program and the instrument and technique evaluation laboratory. Routine calibration procedures and instrument services are discussed.

32628 (PNL-SA—13346, pp D.52-D.62) **US Nuclear Regulatory Commission interests in secondary laboratories.** Cohen, L.K. (Nuclear Regulatory Commission, Washington, DC). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

An approach to the calibration of portable radiation survey instruments by the NRC is discussed. This approach was for NBS, supported by a contract with NRC, to establish a Measurement Assurance Program (MAP) for radiation survey instrument measurements. Through this program laboratories would become secondary calibration laboratories traceable to NBS. The end result would be consistent calibrations with a measurable degree of accuracy and demonstrated traceability to NBS for all NRC radiation survey equipment. This program is outlined in this paper.

32629 (PNL-SA—13346, pp D.63-D.71) **Secondary standards laboratories for ionizing radiation calibrations: the national laboratory interests.** Roberson, P.L.; Campbell, G.W. (Pacific Northwest Lab., Richland, WA). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—). Contract AC06-76RL01830;AC04-76DP03533.

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The national laboratories are probable candidates to serve as secondary standards laboratories for the federal sector. Representatives of the major Department of Energy laboratories were polled concerning attitudes toward a secondary laboratory structure. Generally, the need for secondary laboratories was recognized and the development of such a program was encouraged. The secondary laboratories should be reviewed and inspected by the National Bureau of Standards. They should offer all of the essential, and preferably additional, calibration services in the field of radiological health protection. The selection of secondary laboratories should be based on economic and geographic criteria and/or be voluntary.

32630 (PNL-SA—13346, pp D.72-D.85) **Role of secondary standards laboratories in power reactor survey instrumentation and calibration programs.** Hudson, C.G.; Farrell, W.E.; Skinner, K.A. (Tennessee Valley Authority, Chattanooga). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

Secondary standards laboratories (SSL) presently provide services to health physics instrumentation users. This paper deals with the extent of the present services and potential future services that SSLs might provide to nuclear power plant programs. The role of the SSL in relation to nuclear power reactors and to the National Bureau of Standards (NBS) is presented based on the information obtained from an informal sampling of other power utilities that possess survey instrument programs. Discussions with these utilities indicate that the SSL should continue to provide basic calibration services but also should extend support to other areas such as special calibrations, establishment of uniform maintenance and calibration procedures, development of practical sources and geometries, and performance of evaluative testing of instruments.

32631 (PNL-SA—13346, pp F.2-F.12) **Calibration of neutron survey instruments, scatter corrections for a population of instruments and organizational aspects.** West, L. (Univ. of Arkansas, Fayetteville). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The University of Arkansas is developing a decommissioned reactor site. SEFOR, into a neutron calibration facility for survey instruments. In the relatively small, enclosed cell at SEFOR, wall-scatter corrections for two commercial remmeters of different design are presented for a population of measurements over a period of 1 1/2 years. For the population of measurements, nominal wall-scatter coefficients are 0.38 +- 0.04 (one S.D.) for the Eberline PRS-2 model and 0.29 +- 0.06 for the NRC, Inc. NP-2 model. All measurements are with Cf-252 neutrons moderated by 15 cm of D_2O. Organizational aspects, concerning remmeter calibrations for nuclear power plants, are also briefly discussed.

32632 (PNL-SA—13346, pp F.13-F.34) **NBS facilities for the study of radiation-protection instruments.** Ehrlich, M. (National Bureau of Standards, Gaithersburg, MD). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The radiation-instrument calibration program at NBS is reviewed. Extension to radiation fields other than medical for instrument calibration is quite recent at NBS. At NBS, they now have essentially monoenergetic neutron beams and point and moderated californium-252 sources for the study and calibration of neutron instruments; a beta-particle instrument-calibration facility; a facility simulating a semi-infinite cloud containing a noble-gas radionuclide such as xenon-133; a facility simulating the 6- to 7-MeV photon field arising from the activation of reactor cooling water; and a monoenergetic-electron facility, which eventually may either supplement or partially replace the beta-particle sources. This paper presents a brief discussion of the photon-, beta- particle, and monoenergetic-electron facilities, and of some examples of the types of studies to which they are suited.

32633 (PNL-SA—13346, pp F.35-F.45) **Experiences in calibration of neutron survey instruments.** Schwartz, R.B. (National Bureau of Standards, Gaithersburg, MD). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

For the past several years, NBS has been calibrating neutron survey instruments for outside users, primarily nuclear power plants. In this paper, it is shown that the measured calibration factors for many neutron remmeters vary considerably for nominally identical instruments, and even from one scale to another for the same instrument.

32634 (SLAC-PUB—3910) **Performance of the SLD Central Drift Chamber prototype.** Atwood, W.B.; Carr, J.; Chadwick, G.; Csorna, S.; Hansl-Kozanecka, T.; Hodges, C.; Nauenberg, U.; Nielsen, B.S.; Panvini, R.S.; Prescott, C.Y. (Stanford Linear Accelerator Center, Menlo Park, CA (USA); Colorado Univ., Boulder (USA). Dept. of Physics and Astrophysics; Vanderbilt Univ., Nashville, TN (USA). Dept. of Physics; San Francisco State Univ., CA (USA). Dept. of Physics). Mar 1986. Contract AC03-76SF00515. 7p. (CONF-860272—6). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009779.

From Wire chamber conference; Vienna, Austria (25 Feb 1986).

A two-cell prototype of the SLD Central Drift Chamber has been tested using CO_2-isobutane (92%-8%) at one atmosphere. Average single wire resolution of 55 μm was achieved. Charge division tests indicate a resolution for the final design of $\leq$ 0.5% of wire length. dE/dx separation of π/e should be useful up to at least 7 GeV/c. 100 MHz waveform digitizers were used in parallel with conventional timing and integration techniques. The results show equivalent performance for single tracks and a two pulse resolution better than 1 mm. 7 refs., 7 figs., 1 tab.

32635 (UFRJ-IF—85/14) **Monte Carlo model for fission-in-flight experiments. 1. Cylindrical detectors.** Magalhaes, S.D. de. (Rio de Janeiro Univ. (Brazil). Inst. de Fisica). 1985. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701984.

A Monte Carlo evaluation of the expected distribution of isomeric fission fragments, on the plastic detector, in a typical fission-in-flight experimental set-up is presented.

32636 **Photosensitive dopants for liquid argon.** Anderson, D.F. (Fermi National Accelerator Lab., Batavia, IL, USA. Particle Detector Group). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **242**: No. 2, 254-258(1 Jan 1986).

Two photosensitive dopants for liquid argon are discussed. Trimethylamine is shown to be efficient for converting the excitons into collected charge, as well as approximately 40% of the recombination photons. A greater improvement in energy resolution, for 5.5 MeV alphas, is measured, which is greater than can be accounted for by the increase in charge collected. Possible applications are also discussed.

32637 **Improved method for the stabilization of NaI-photomultiplier gamma detectors against thermal and other drift.** Zucker, M.S. (Brookhaven National Lab., Upton, NY, USA). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **242**: No. 2, 306-314(1 Jan 1986).

Alpha peaks have been used as part of servo systems to stabilize NaI-photomultiplier gamma detectors against drift. However, alpha peaks shift with temperature change differently than do gamma peaks, thus spoiling what would otherwise be a workable scheme for stabilizing against probably the most serious source of NaI-p.m. detector drift, namely thermal effects. It has been found possible to accurately compensate for the difference in the shift with temperature versus gamma peaks using the signal derived from a thermistor in thermal contact with the NaI crystal to control the bias of a discriminator in the servo circuit. The servo circuit utilizing this principle has been used in commercial multichannel analyzers of the type intended for field use under adverse ambient conditions.

32638 **Large aperture spectrometer at Fermilab to study high mass dimuons.** Anassontzis, E.; Katsanevas, S.; Kostarakis, P.; Kourkoumelis, C.; Markou, A.; Resvanis, L.K.; Voulgaris, G.; Binkley, M.; Cox, B.; Enagonio, J. (Athens Univ., Greece; Fermi National Accelerator Lab., Batavia, IL, USA; McGill Univ., Montreal, Quebec, Canada; Michigan Univ., Ann Arbor, USA; Shandong Univ., Jinan, China). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **242**: No. 2, 215-227(1 Jan 1986).

A large acceptance forward spectrometer located in a unique antiproton enriched beam has been used at Fermi National Accelerator Laboratory by Experiment 537 to study the production of high mass muon pairs. When the beam was operated at a momentum of 125 GeV/c, it had a flux of 1.5×10^7 particles per second of which 18% were antiprotons. The spectrometer was of closed geometry design and used drift chambers as the tracking elements. Operating over a relatively short period, the experiment accumulated the largest sample of antiproton-induced high mass dimuons of any experiment to date. The contamination of this data by pion-induced dimuons was less than 0.5%.

32639 **Performance comparison of thorium track, polycarbonate, and CR-39 neutron dosimeters.** Sims, C.S.; Swaja, R.E. (Oak Ridge National Lab., TN, USA). *Nuclear Tracks;* **10**: No. 3, 461-465(1985). (CONF-8407162—).

From Fission-track dating workshop; Troy, NY, USA (31 Jul 1984).

Personnel dosimetry intercomparison studies have been ongoing at the Oak Ridge National Laboratory since 1974. Track neutron dosimeters have been used by various participants in each of these studies to date. Specific types of track dosimeters used include thorium track, polycarbonate, CR-39, and combination (CR-39 and polycarbonate). The results of 313 track dosimeter measurements made by participants during 61 operations of the Health Physics Research Reactor in 6 different shielding conditions are presented, compared, and analyzed.

4402 Radiation Effects On Instrument Components, Instruments, Or Electronic Systems

REFER ALSO TO CITATION(S) 31852, 32590

32640 (DOE/ER/40048—102-L4, pp 65) **Simulation of cosmic-ray upset in integrated circuits.** Malone, C.J.; Smith, L.S.; Zoutendyk, J.A. (California Institute of Technology, Pasadena). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The tandem Van de Graaff accelerator was used to determined experimentally the critical charge values characteristic of a bipolar random-access memory chip. Bromine ions with kinetic energies ranging from 20 meV to 117 MeV (the latter energy was obtained with a charge state of 12 and a terminal voltage of 9 MV) were used to simulate cosmic-ray upset in the solid-state device. The data obtained for upset cross section as a function of Br-ion energy (collected charge) were in excellent agreement with theoretical modeling done earlier. Structure in the data which was predicted by the theoretical model was observed by selecting twenty-two values of Br-ion energy within the 20-117 MeV range. This experiment is the first one in which the physics governing the interaction of an ion track within a complex integrated circuit has been examined in detail.

4403 Miscellaneous Instruments

REFER ALSO TO CITATION(S) 31312, 32752, 32873

32641 **(BARC—1271) Progress report [of] Technical Physics and Prototype Engineering Division, April 1982-March 1984.** Ramamurthi, S.S.; Chaudhry, R. (Bhabha Atomic Research Centre, Bombay (India)). 1985. 233p. NTIS (US Sales Only), PC A11/MF A01. File Number DE86702082.

The work done by the Technical Physics and Prototype Engineering Division of the Bhabha Atomic Research Centre (BARC) at Bombay during the period from April 1982 to March 1984 is described in the form of summaries. The main thrust of the work of the Division is towards designing, developing, fabricating and if needed, producing on a large scale various instruments, equipment and components required for the programmes of the BARC and the Department of Atomic Energy. The summaries describing the work are grouped under the headings:(1) vacuum, (2) surface analysis, (3) mass spectrometry, (4) electronics, (5) cryogenics, (6) crystals and detectors, (7) glass technology and devices, and (8) optoelectronics. A list of publications of the staff-members of the Division during the report period is given.

32642 **(BNL—37619) Circular dichroism spectroscopy using vacuum ultraviolet synchrotron radiation from U9A beamline: instrument and future applications.** Wickramaaratchi, M.A.; Premuzic, E.T.; Lin, M.; Snyder, P.A. (Brookhaven National Lab., Upton, NY (USA); Florida Atlantic Univ., Boca Raton (USA). Dept. of Chemistry). Jan 1986. Contract AC02-76CH00016. 32p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010541.

A vacuum ultraviolet circular dichroism (CD) spectrometer for use with Synchrotron Radiation is described. This instrument is an improved modified version of an earlier instrument. Specifically the use of a pile-of-plates polarizer, an adjustable signal processor (DC controller) and a modified detection system enables recording of spectra in the vacuum ultraviolet region. The first gas phase CD spectra of (+) and (-) carvones are presented. Application of CD spectroscopy in the vacuum uv to visible region in petroleum chemistry is described. Further, the use of CD at specific wavelengths as a chromatographic detector of optically active substances is also discussed.

32643 **(CERN—85-16) Automation by microcomputer of a geodetic distance measuring instrument: The distinvar.** Bain, G.; Bore, C.; Coosemans, W.; Dupont, J.; Fabre, J.P.; Gavaggio, R.; Peron, F. (European Organization for Nuclear Research, Geneva (Switzerland)). 8 Nov 1985. 35p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702083.

This report has been translated and updated from the original French version CERN--84-07.

The distinvar is an instrument for the precision measurement of distances up to 50 m. This report describes the latest developments at CERN which have improved its resolution to 2 μm and increased its speed of use. Measurements are automated by incorporating a microcomputer programmed in BASIC.

32644 (DOE/ER/40048—102-L4, pp 55-56) **AMS: technical improvements.** Balsley, D.; Farwell, G.W.; Fauska, H.; Grootes, P.M.; Leach, D.D.; Schmidt, F.H. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Last year the authors reported progress on two systems of normalization of the rare isotope beam (particle counting rate, ^{14}C or ^{10}Be) against the stable isotope beam or beams (/sup 12,13/C or ^{9}Be ion current). In the concurrent monitoring method, the abundant isotope (e.g., ^{13}C) is monitored at the low-energy end of the accelerator while the rare isotope (e.g., ^{14}C) is monitored simultaneously following acceleration and high-energy ion analysis. In the sequential transmission method, the rare and abundant isotopic ion beams are alternated by adjustment of the entire set of accelerator parameters. The recent advent of a two-level, nuclear-magnetic-resonance-controlled isotope alternation system has greatly enhanced the effectiveness of the sequential transmission method and the authors experienced little difficulty taking data on carbon from tree-ring segments with about +/ 12% accuracy for a single measurement.

32645 (DOE/ER/40048—102-L4, pp 56-58) **Isotope alternation system: two-level, NMR-controlled rapid switching.** Farwell, G.W.; Fauska, H.; Leach, D.D.; Schmidt, F.H. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

In the sequential transmission method of normalization in AMS the magnetic parameters of the accelerator must be alternated between their values for the lighter and the heavier isotopes with as little loss of time as possible. Rapid changing of these parameters has been effected through a combination of computer control and nuclear magnetic resonance (NMR) search and lock control.

32646 **(FEI—1459) Specific features of neutron diffractional optics in simple and Soller collimations.** Levdik, V.A.; Bykov, V.N.; Golovkin, V.S.; Miron, N.F. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1983. 31p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86702081.

Alternation curves with the Bragg angle of a two-crystal neutron spectrometer resolution at different combinations of the device parameters under conditions of simple collimation are experimentally obtained on monocrystalline samples. Regularities of neutron-diffraction reflex formation are considered and analytical dependences of the device resolution on its parameters and Bragg angles for conditions of simple and Soller collimation are derived in linear approximation. The calculation is shown to well agree with the experiment for perfect samples, and it is stated that at large Bragg angles simple collimation ensures better resolution of the device than Soller one with identical parameters. Dependence of the device resolution on double differential functions of collimator passing is established; representation on these functions is introduced for the first time. Some other peculiarities of neutron-diffraction optics are revealed.

32647 (INIS-BR—462, pp 290-294) **Design and construction of an automatic texture goniometer.** Lima, N.B. de; Pontes, E.W.; Monteiro, P.R.B.; Imakuma, K. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The project and construction of a two-axis automatic goniometer, operated by step motors, adaptable to the scanning goniometer SG-7 or SG-8 fabricated by Rigaku-Deuki. To allow the operation of this texture goniometer, computer codes have been developed.

32648 (LBL—19100, pp 56-58) **X-ray laboratories.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

By October 1984, two of the Center's laboratories - the x-ray mirror coating lab and the visible optics lab - were well on the way to completion. The others - the soft x-ray spectroscopy lab, the low-energy electron spectroscopy lab, and the molecular multilayer lab - awaited the arrival of equipment from the University of Hawaii. The layout of the Center's labs is shown in Fig. 30 as we expect them to look in the spring of 1985, when the labs will be fully operational.

32649 **(SAND—85-2002) Calibration procedure for flux-gages used in solar environments.** Mulholland, G.P.; Hall, I.J.; Edgar, R.M.; Maxwell, C.R. (New Mexico State Univ., Las Cruces (USA); Sandia National Labs., Albuquerque, NM (USA); Technadyne, Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 40p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010307.

A statistical calibration procedure for flux-gages exposed to a solar environment is proposed. This paper discusses the procedure as it is applied to data obtained from twenty-three gages tested at the Central Receiver Test Facility's solar furnace located at Sandia National Laboratories. A detailed evaluation of one gage is presented to illustrate the method and the results for the remaining twenty-two gages are given in tabular form. An alternate procedure is also presented for gages whose "history" is known.

32650 **(UCRL—93890) Large area 200 psec gated microchannel plate detector.** Eckart, M.J.; Hanks, R.L.; Kilkenny, J.D.; Pasha, R.; Wiedwald, J.D.; Hares, J.D. (Lawrence Livermore National Lab., CA (USA); X-Opt, Inc., FL (USA)). Mar 1986. Contract W-7405-ENG-48. 14p. (CONF-860324—27). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010537.

From High temperature plasma diagnostics; Hilton Head Island, SC, USA (9 Mar 1986).

Results are presented with a 15 mm wide gated microchannel plate uv and x-ray detector. The active area is part of a 6 ohm transmission line driven by an electronically generated gate pulse. The microchannel plate is coated with CsI allowing tests with a frequency quadrupled, high repetition rate 1.05 μm laser. Results showing optical gate widths as short as 100 psec are presented.

32651 **(UCRL—93991) Systematic parameter study of optical directional coupler analog modulators designed to operate at 810 nm: characterization techniques and preliminary results.** Lowry, M.; Roeske, F.; Jander, D.; McWright, G.; Koo, J.; Slivinsky, V. (Lawrence Livermore National Lab., CA (USA)). Jan 1986. Contract W-7405-ENG-48. 10p. (CONF-860622—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86006729.

From OSA/IEEE conference on lasers and electro-optics (CLEO '86); San Francisco, CA, USA (9 Jun 1986).

Measurements are presented of the crossover length, electro-optical transfer function, pulsed electrical response, and single-shot pulsed electro-optic response with streak camera recording. Measurements of a "bulk" and "surface" photorefractive effect are presented. All measurements were performed at 810 nm.

32652 **Camac interface for digitally recording infrared camera images.** Dyer, G.R. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Review of Scientific Instruments;* 57: No. 6, 1107-1115(Jun 1986). Contract AC05-84OR21400.

An instrument has been built to store the digital signals from a modified imaging infrared scanner directly in a digital memory. This procedure avoids the signal-to-noise degradation and dynamic range limitations associated with successive analog-to-digital and digital-to-analog conversions and the analog recording method normally used to store data from the scanner. This technique also allows digital data processing methods to be applied directly to recorded data and permits processing and image reconstruction to be done using either a mainframe or a microcomputer. If a suitable computer and CAMAC-based data collection system are already available, digital storage of up to 12 scanner images can be implemented for less than $1750 in materials cost. Each image is stored as a frame of 60 x 80 eight-bit pixels, with an acquisition rate of one

frame every 16.7 ms. The number of frames stored is limited only by the available memory. Initially, data processing for this equipment was done on a VAX 11-780, but images may also be displayed on the screen of a microcomputer. Software for setting the displayed gray scale, generating contour plots and false-color displays, and subtracting one image from another (e.g., background suppression) has been developed for IBM-compatible personal computers.

32653 **Remotely readable fiber optic compass.** Migliori, A.; Swift, G.W.; Garrett, S.L. (to Dept. of Energy, Washington, DC). US Patent 4,577,414. 25 Mar 1986. Filed date 30 Apr 1985. vp.

A remotely readable compass is described consisting of: a magnet rotatably mounted in a compass body so as to be freely rotatable with respect to the compass body, a rotatable sheet polarizer affixed to the magnet so as to be rotatable with respect to the compass body with the magnet about a common axis of rotation; first and second excitation optical fibers affixed to the compass body and terminating adjacent the rotatable sheet polarizer so as to direct light propagated through the fibers onto the rotatable sheet polarizer, and first and second return optical fibers affixed to the compass body and positioned respectively opposite the rotatable sheet polarizer from the excitation fibers, so as to receive light which is emitted from the first and second excitation fibers and transmitted through the rotatable sheet polarizer; and first and second fixed sheet polarizers, the first fixed sheet polarizer being affixed to the compass body so as to be optically interposed between the first excitation fiber and the first return fiber, the second fixed sheet polarizer being affixed to the compass body so as to be interposed between the second excitation fiber and the second return fiber, the fixed sheet polarizers having optical axes which are oriented substantially orthogonally with respect to one another; whereby the orientation of the magnet with respect to the compass body can be determined by transmitting two light beams through the excitation fibers, through the fixed sheet polarizers and through the rotatable sheet polarizer, and measuring the ratio of the intensities of the resulting light beams received in the return fibers.

32654 **Analytical chemistry instrumentation.** Laing, W.R. (ed.). Chelsea, MI; Lewis Publishers, Inc. (1986). 342p. (CONF-8510151—). Lewis Publishers, Inc., 121 S. Main Street, P.O. Drawer 519, Chelsea, MI 48118. File Number TI86010004. Contract AC05-84OR21400.

From 28. Oak Ridge National Laboratory conference on analytical chemistry; Knoxville, TN, USA (1 Oct 1985).

Separate abstracts were prepared for 48 papers in these conference proceedings. The topics covered include: analytical chemistry and the environment; environmental radiochemistry; automated instrumentation; advances in analytical mass spectrometry; Fourier transform spectroscopy; analytical chemistry of plutonium; nuclear analytical chemistry; chemometrics; and nuclear fuel technology. (LEW)

4404 Well Logging Instrumentation

32655 **(LA-UR—86-980) Low radioactivity spectral gamma calibration facility.** Mathews, M.A.; Bowman, H.R.; Huang, L., H.; Lavelle, M.J.; Smith, A.R.; Hearst, J.R.; Wollenberg, H.A.; Flexser, S. (Los Alamos National Lab., NM (USA); Lawrence Berkeley Lab., CA (USA); East China Petroleum Inst., Dongying, Shandong; EG and G Energy Measurements, Inc., Las Vegas, NV (USA); Lawrence Livermore National Lab., CA (USA)). 1986. Contract W-7405-ENG-36. 16p. (CONF-8606105—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86008745.

From 27. annual logging symposium of the Society of Professional Well Log Analysts; Houston, TX, USA (9 Jun 1986).

A low radioactivity calibration facility has been constructed at the Nevada Test Site (NTS). This facility has four calibration models of natural stone that are 3 ft in diameter and 6 ft long, with a 12 in. cored borehole in the center of each model and a lead-shielded run pipe below each model. These models have been analyzed by laboratory natural gamma ray spectroscopy (NGRS) and neutron activation analysis (NAA) for their K, U, and Th content. Also, 42 other elements were analyzed in the NAA. The ^{222}Rn emanation data were collected. Calibrating the spectral gamma tool in this low radioactivity calibration facility allows the spectral gamma log to accurately aid in the recognition and mapping of subsurface stratigraphic units and alteration features associated with unusual concentrations of these radioactive elements, such as clay-rich zones.

45 EXPLOSIONS AND EXPLOSIVES

4501 Chemical

REFER ALSO TO CITATION(S) 31354, 32404, 32693

32656 (CONF-850706—Vol.3, pp 780-783) **Influence of reactive cases on airblast from high explosive.** Filler, W.S. (Naval Surface Weapons Center, White Oak, MD). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Airblast results are presented from high explosive charges surrounded by casings that are potentially reactive in air. Data are provided from two different test efforts: 5 kg and 750 kg cylindrical charges with 1/d-1 fired to obtain shock wave pressure time histories in the 200 to 2 psi peak shock overpressure range. The data are shown to strongly support a mechanism proposed earlier to explain anomalous shockwave attenuation with distance for inert friable castings.

32657 (CONF-850706—Vol.3, pp 784-794) **Study of booster materials with electromagnetic particle velocity gauges.** Philippart, D.A. (Royal Armament Research and Development Establishment, Sevenoaks, England). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

A particle velocity gauge system incorporating a number of novel ideas has been designed and made and results obtained for the UK booster explosives, Tetryl and Debrix 2. Further, a glass mousetrap has been successfully developed and its performance measured. On the basis of the work done, more refined experiments are planned, in particular the use of perspex mousetraps for studying shock to detonation transitions.

32658 (CONF-850706—Vol.3, pp 795-800) **Applications of fiber optics to detonation events.** Lu, P.; Naiman, E.; Voreck, W.E. (Army Armament Research and Development Center, Dover, NJ). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

The fiber optics technique and choice of optical fiber are discussed. The application of the fiber optics technique in characterizing the detonation wave tilt in a cased shaped charge is also discussed. The wave tilt data is consistent with the caseless charge data taken via inverse multi-streak technique. Detonation velocity data of a multirack plate recorded both by ionization probes and fiber optics are described.

32659 (CONF-850706—Vol.3, pp 801-807) **VISAR: interferometer quadrature signal recording by electronic streak camera.** Hemsing, W.F. (Los Alamos National Lab., NM). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

A demonstration to record the four quadrature signals from a push-pull VISAR velocity interferometer using an electronic streak camera is described. Optical fibers were used to transmit the interferometer outputs to the camera photocathode. Brightness variations of these signals were recorded on film during the experiment. Velocity information was later recovered from this record to give a continuous velocity history. Anticipated advantages over previous methods are increased time resolution, the ability to record multiple velocities simultaneously and greater dynamic range.

32660 (CONF-850706—Vol.3, pp 808-813) **Energetic response of propellants to high velocity impact.** Green, L.; James, E.; Lee, E. (Lawrence Livermore National Lab., CA). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

An impact impulse on a full density intact propellant or explosive must be of high intensity (several gigapascals) to initiate detonation. Accident situation impact impulses are typically an order of magnitude less intense. The fact that detonation can arise from such lower level impulses is almost always the result of secondary compression of damaged (i.e. lower density) material. A spectrum of possible conditions was investigated in order to evaluate threshold impact values which will cause detonation in damaged propellants. The results of new experiments involving in situ damage and impact of two propellants are reported.

32661 (CONF-850706—Vol.3, pp 814-822) **Microwave interferometer techniques for detonation study.** Stanton, P.L.; Venturini, E.L.; Dietzel, R.W. (Sandia National Labs., Albuquerque, NM). 1985. NTIS, PC A11/MF A01. File Number DE86006785. Contract AC04-76DP00789.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Techniques have been developed to improve resolution in microwave interferometry of detonating explosives. Unwanted reflections in the measurement arm of the interferometer result in phase distortion of the recorded signal. By using tuning techniques, unwanted reflections can be virtually eliminated, and phase distortion is minimized, for some experimental conditions. The use of a quadrature detector and an intensity monitor also improve the resolution of the interferometer. Data obtained in several detonation experiments are presented and interpreted.

32662 (CONF-850706—Vol.3, pp 823-831) **Eight-inch diameter, heavily confined card gap test.** Foster, J.C. Jr.; Forbes, K.R.; Gunger, M.E.; Craig, B.G. (Air Force Armament Lab., Eglin, FL). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

An instrumented card gap test which is useful for investigating the response of explosives to low pressure, long duration shock stimuli has been developed. The test was designed to screen for an explosive's (or propellant's) propensity to detonate or react violently as result of shock induced sympathetic detonation of large ordnance such as general purpose bombs. Both donor and acceptor are encased in an 8 in. outside diameter by 0.35-in. wall steel pipe. The donor is Composition B, one diameter long, and point-initiated on axis. Acceptors are two diameters long. Typically, both donor and acceptor tubes are closed with 0.50-in. thick steel end plates. Plexiglass, of varying thickness, and steel end plates are used to control the shock amplitude transmitted into the acceptor. The acceptor is instrumented with piezoelectric time of arrival pins. The assembly rests on a vee-groove wood block which rests on a 1 in thick armor plate; the armor plate serves as a fragment witness. Hydrocode calculations were performed to describe input pressure profile as a function of gap thickness and configuration. The calculations show that the end plates result in significantly longer pressure durations and lower peak pressures than other gap tests, and in a more realistic mock of the shock loading experienced in large ordnance sympathetic detonation experiments. Results presented include data for tritonal, Composition B, TNT/WAX, and TNT/NQ/WAX.

32663 (CONF-850706—Vol.3, pp 832-838) **Chemical reaction of explosives and gun propellant during high acceleration.** Lanzerotti, M.Y.D.; Pinto, J. (Army Armament Research and Development Center, Dover, NJ). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

The fracture phenomena of energetic materials during high acceleration have been studied in an ultracentrifuge. The recovered samples have been studied by x-ray photoelectron spectroscopy (XPS) and electron paramagnetic resonance (EPR). The results of these measurements indicate that chemical reaction has occurred in TNT, TNT-1% HNS, and M30 propellant as a result of fracture and impact during high acceleration.

32664 (CONF-850706—Vol.3, pp 839-847) **Continuous observation of Mach bridge and Mach phenomena.** Souletis, J.; Groux, J. (Centre de recherches du Bouchet, Vert-Le-Petit, France). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

The Mach reflection was studied in two distinct cases: first, the intersection of two oblique plane waves and secondly, a conical wave with constant velocity. This study has been applied to various plastic bonded explosives. The first device makes it possible to observe the formation of the phenomenon and to differentiate among the various compositions on the basis of the length of their reaction. The second makes it possible to provide an accurate characterization of the state of the detonation that is reached in the center of the Mach wave and to compare measurements and equations of state.

32665 (CONF-850706—Vol.3, pp 848-855) **Experimental investigation of the role of shear in initiation of detonation by impact.** Howe, P.M.; Gibbons, G. Jr.; Webber, P.E. (Army Material Command, Aberdeen Proving Ground, MD). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Heavily confined explosive targets were subjected to impacts by explosively launched plates and by penetrating fragments. In each experiment, the damaged explosive was collected, sectioned, and examined by optical and scanning electron microscopy. A number of different types of damage was observed, each of which is expected to contribute to the initiation process. The response of the explosive to impacts is more complicated than originally thought. Since the explosive is mechanically weak, the conditions for shear damage are almost entirely controlled by casing response to the impact, and the domain over which severe damage occurs is controlled by case deformation. The authors are as yet unable to rank these various explosive damage mechanisms with respect to their importance to the initiation process.

32666 (CONF-850706—Vol.3, pp 865-871) **Composite explosives for metal acceleration: the effect of detonation temperature.** McGuire, R.R.; Finger, M. (Lawrence Livermore National Lab., CA). 1985. NTIS, PC A11/MF A01. File Number DE86006785. Contract W-7405-ENG-48.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Previous work in the area of composite explosives has emphasized the necessity of small particle size and intimate contact between fuel and oxidizer in obtaining prompt performance from fuel-oxidizer mixtures. This work has provided a basis for the definition of a composite explosive as an explosive system that requires the transport, mixing and subsequent reaction of the initial decomposition products of the system components in order to achieve the predicted detonation performance. A general working model and experimental evidence demonstrating the importance of detonation temperature in achieving performance from composite explosives in metal acceleration experiments are presented.

32667 (CONF-850706—Vol.3, pp 872-876) **Dynamics of shock-induced energy flux in molecular bonds.** Karo, A.M.; Mehlman, M.H.; Hardy, J.R. (Lawrence Livermore National Lab., CA). 1985. NTIS, PC A11/MF A01. File Number DE86006785. Contract W-7405-ENG-48.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Over the past ten years many computer studies of shock propagation in condensed media have been made. These studies employed the techniques of computer molecular dynamics (CMD), based on computer solutions of the classical equations of motion for the individual atoms in the condensed media. Recently, the information obtained was reevaluated in order to achieve a flexible compromise between brute force averaging and continual monitoring of the detailed motion of the individual atoms. The method chosen is

Fourier analysis in the temporal domain of the motions of groups of atoms which can be preselected. An analysis of early canonical studies and of new data on disordered systems is presented. The present work also utilizes current codes which contain neighborhood look-up procedures designed to examine the system at regular intervals and to determine which bonds should be retained, removed, or added as the system rearranges under shock loading.

32668 (CONF-850706—Vol.3, pp 877-883) **Simulation of the initiation of detonation in an energetic molecular crystal: the overdriven case.** Trevino, S.F.; Tsai, D.H. (Armament Research and Development Center, Dover, NJ). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

The method of molecular dynamics was employed in a study of the detonation process in a model of a molecular crystal capable of undergoing exothermic reactions by dissociation. The model was initially heated at the boundary. Simultaneously it was subjected to shock compression by mechanical impact. The results showed both thermally initiated and shock initiated reactions which combined to form a propagating reaction front, driving a shock wave ahead of it. The velocity of the reaction front depended strongly on the rate of energy transfer from the shock compression to internal modes of the molecules. Under strong compression, the shock initiation time was short, and a steady detonation wave profile was obtained which corresponded to an overdriven case below the Chapman-Jouguet condition.

32669 (CONF-850706—Vol.3, pp 884-892) **Modeling short pulse duration shock initiation of solid explosives.** Tarver, C.M.; Hallquist, J.O.; Erickson, L.M. (Lawrence Livermore National Lab., CA). 1985. NTIS, PC A11/MF A01. File Number DE86006785. Contract W-7405-ENG-48.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

The chemical reaction rate law in the ignition and growth model of shock initiation and detonation of solid explosives is modified so that the model can accurately simulate short pulse duration shock initiation. The reaction rate law contains three terms to model the ignition of hot spots by shock compression, the slow growth of reaction from these isolated hot spots, and the rapid completion of reaction as the hot spots coalesce. Comparisons for PBX 9404 between calculated and experimental records are presented for the electric gun mylar flyer plate system, the minimum priming charge test, embedded manganin pressure and particle velocity gauges, and VISAR particle velocity measurements for a wide variety of input pressures, rise times and pulse durations. The ignition and growth model is now a fully developed phenomenological tool that can be applied with confidence to almost any hazard, vulnerability or explosive performance problem.

32670 (CONF-850706—Vol.3, pp 893-897) **DDT in RDX and ball powder: behavior of the porous bed.** Samirant, M. (Franco-German Research Institute, Saint-Louis, France). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

In highly confined pulverulent RDX-wax the transition from deflagration to detonation is a rapid and well-localized phenomenon, resulting from a shock running downstream. In ball powder, this transition is a progressive and continuous phenomenon. It is shown that the transition mode is not directly related to the chemical composition of the reactive bed, but that this difference of behavior is due to mechanical properties of the grains.

32671 (CONF-850706—Vol.3, pp 898-903) **Theoretical equations of state for the detonation products of explosives.** Kerley, G.I. (Sandia National Labs., Albuquerque, NM). 1985. NTIS, PC A11/MF A01. File Number DE86006785. Contract AC04-76DP00789.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Equations of state (EOS) for the detonation products of explosives were calculated from EOS for the individual chemical species, using the approximation of ideal mixing. The theory is applied to 15 explosives of varying composition and loading density. To understand these explosives, it is necessary to identify the important reaction products and to determine their EOS parameters. For explosives that contain no carbon or are oxygen-rich, the principal species and their EOS are known reasonably well, and the theory gives good results. For carbon-rich explosives, it is found that formic acid competes with carbon as a reaction product. If formic acid is omitted from the equilibrium, the data for PETN and RDX cannot be fit with any reasonable modification to the carbon EOS. An EOS for formic acid is constructed, and the theory gives good results for all classes of CHNO explosives.

32672 (CONF-850706—Vol.3, pp 904-910) **Supra-compression of LX-07, LX-17, PBX-9404, and RX-26-AF and the equations of state of the detonation products.** Green, L.; Lee, E.; Mitchell, A.; Tarver, C. (Lawrence Livermore National Lab., CA). 1985. NTIS, PC A11/MF A01. File Number DE86006785. Contract W-7405-ENG-48.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Shock velocity vs. input pressure in the range of 32 to 112 GPa has been measured for LX-07, LX-17, PBX-9404, and RX-26-AF. The average shock velocity for the first 2.8-mm of run was found to be within one percent of that for the run from 2.0 to 4.8-mm. Supra-compressive states of PBX-9404 were reflected to higher pressures by a copper barrier and the velocity in the copper measured. They were also rarefied by a magnesium barrier and the velocity in the magnesium measured. Equations of state derived for the reaction products of these explosives and normalized to accepted C-J pressures do not adequately predict measurements at pressures substantially greater than detonation pressure, normalization to lower than accepted C-J pressures is required to fit the data. The C-J state defined by the supra-compressive experiments appears to be different from the C-J state defined by the usual C-J pressure measurement.

32673 (CONF-850706—Vol.3, pp 911-921) **Relationship between the shock sensitivity and the solid pore sizes of TATB powders pressed to various densities.** Lee, R.; Bloom, G.; Von Holle, W.; Weingart, R.; Erickson, L.; Sanders, S.; Slettevold, C.; McGuire, R. (Lawrence Livermore National Lab., CA). 1985. NTIS, PC A11/MF A01. File Number DE86006785. Contract W-7405-ENG-48.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Mercury intrusion porosimetry measurements have been made on samples pressed from three different types of TATB powders having quite different particle size distributions. The samples had densities ranging from 74-99% of theoretical maximum density. Results of the porosimetry measurements are compared with shock initiation thresholds measured on the same materials. The growth of reaction in sustained pressure experiments is also compared for two of the TATB types.

32674 (CONF-850706—Vol.3, pp 922-930) **Mechanical properties of PBX's and their behavior during drop weight impact.** Field, J.E.; Palmer, S.J.P.; Pope, P.H.; Sundararajan, R.; Swallowe, G.M. (Cavendish Lab., Cambridge, England). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Experiments are described on the deformation and ignition behavior of a range of explosives, including polymer bonded explosives (PBX's). An instrumented drop-weight apparatus was used to obtain stress-strain curves for strain rates in the range 10^2 to $10^3\ s^{-1}$. A novel drop-weight apparatus with transparent anvils allowed high-speed photographic recording of the impact and ignition processes. Laser speckle, used in conjunction with a specimen loaded in the Brazilian test geometry gave tensile strength and strain to failure data of PBX's. Finally, a modified Hopkinson bar apparatus gave data at strain rates up to $5 \times 10^4 s^{-1}$.

32675 (CONF-850706—Vol.3, pp 931-939) **Sub-ignition reactions at molecular levels in explosives subjected to impact and underwater shock.** Sharma, J.; Hoffsommer, J.C.; Glover, D.J.; Coffey, C.S.; Forbes, J.W.; Liddiard, T.P.; Elban, W.L.; Santiago, F. (White Oak Lab., Silver Spring, MD). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

To determine the scarce reaction products of explosives in the sub-ignition regime, a combination of sensitive analytical techniques, such as X-ray Photoelectron Spectroscopy (XPS), Thin Layer Chromatography (TLC), and Chemical Ionization Mass Spectrometry (CIMS) has been applied. RDX, TNT, AP, and TATB have been subjected to drop-weight impact or to an underwater shock at a level very close to ignition and the solid residues have been investigated. Impacted RDX showed transformation into nitroso compounds as well as compounds having the functionality of melamine. The impacted trinitroso derivative of RDX showed loss of nitroso groups, together with the formation of further reduced nitrogen products. Impacted TNT yielded anthranil, nitrile, and aldehyde-oxime as decomposition products. Similarly TATB evidenced furoxan and furazan products. All of these reaction products are similar to those of thermal decomposition. In the case of TATB and TNT, creation of water molecule during the formation of furazan and anthranil indicates an important exothermic step. The present work shows that hot spot formation involves thermally decomposed intermediate products, some of which may be less stable than the original explosives.

32676 (CONF-850706—Vol.3, pp 940-951) **Deuterium kinetic isotope effect: an experimental probe for the molecular processes governing the initiation of RDX, HMX, and TNT.** Bulusu, S.; Weinstein, D.I.; Autera, J.R.; Anderson, D.A.; Velicky, R.W. (Army Armament Research and Development Center, Dover, NJ). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

An isothermal TGA (thermogravimetric analysis) study of the decomposition of RDX, HMX and the respective deuterated analogs, RDX-d_6 and HMX-d_8 has been carried out. In RDX, a kinetic isotope effect (KIE) (K/sub h//K/sub d/) of 1.5 was observed for the first time in the temperature range, 200-216°. In the HMX decomposition, an isotope effect of ~ 2.0 was consistently obtained in the temperature range, 237-282°C with no apparent temperature dependence. A previously known kinetic isotope effect in the TNT-α-d_3 decomposition was also confirmed. In each of these three substances studied the KIE produced a small but definite decrease in shock sensitivity measured by the exploding metal foil method. These results indicate that the rate-determining steps in the thermal decomposition and the chemical process of initiation are likely to be the same. Thus, the kinetic isotope effect approach, where applicable, offers a novel experimental probe to test the similarity or otherwise of the rate-limiting steps of the slow decomposition and the fast, escalating reactions of the initiation. Possible rate-limiting steps and reaction mechanisms are discussed.

32677 (CONF-850706—Vol.3, pp 952-956) **Paramagnetic resonance of radicals in decomposed trinitroaromatics.** Owens, F.J. (Army Armament Research and Development Center, Dover, NJ). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Electron paramagnetic resonance (EPR) has been used to identify radicals produced in the uv and thermal decomposition of tetryl, 2,4,6 TNT, 3,4,5 TNT, 3,5 DNT, 3,5 Dichloro-TNT, Picramide and DATB.

32678 (CONF-850706—Vol.3, pp 957-965) **Role of shock and shear mechanisms in the initiation of detonation by fragment impact.** Howe, P.M. (Army Ballistic Research Lab., Aberdeen, MD). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

The collection of experimental data on the impact response of explosives indicates that at least two mechanisms are involved. Much of the data are interpretable in terms of a classical shock initiation mechanism. Thus, the dependence of the initiation threshold velocity upon contact area of the impactor and independence of the threshold velocity upon length, to diameter ratios in excess of 0.25, are entirely consistent with classical shock initiation models which emphasize the importance of peak pressure and shock duration. Other data are quite clearly inconsistent with a classical shock initiation mechanism but are consistent with a macroscopic shear mechanism. TNT was found to show evidence of an initiation mechanism controlled by macroscopic shear. Very weak evidence was found to support a macroscopic shear mechanism for composition B. Evidence in the literature was found to support a shear controlled mechanism for porous tetryl.

32679 (CONF-850706—Vol.3, pp 966-975) **Cavity collapse ignition of Composition B in the launch environment.** Starkenberg, J.; McFadden, D.L.; Lyman, O.R. (Army Ballistic Research Lab., Aberdeen, MD). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Experiments using the activator at the Ballistic Research Laboratory have been pursued for a number of years with an eye toward clarifying the mechanisms involved in the premature ignition of high explosives in the setback environment. Recently, a series of experiments was conducted in which controlled cavities in cast Composition B (comp B) were subjected to deformation both with and without simultaneous air compression as well as air compression without deformation. The dimple tests were designed to accomplish this. There are three variations of the dimple test. In the standard dimple test, a cylindrical cavity or dimple of controlled depth and diameter is case into one end of the explosive sample. In another variation, vacuum hardware is used. In a third variation, the dimple is cast into a piece of Dow Corning Sylgard 182 which is placed in contact with an undimpled explosive sample. In the vacuum dimple test, only deformation heating can produce an ignition. In the Sylgard dimple test, only air compression heating occurs. Both heating mechanisms are combined in the dimple test. To date, only comp B has been subjected to dimple testing. As a result of the work thus far, it was found that when the air compression and compressive heating mechanisms are combined the dominant ignition mechanism is compressive heating of air strongly influenced by the cavity collapse geometry and possibly by alteration of the state of the explosive surface.

32680 (CONF-850706—Vol.3, pp 976-986) **Reaction rates from electromagnetic gauge data.** Vorthman, J.; Andrews, G.; Wackerle, J. (Los Alamos National Lab., NM). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

The determination of reaction rates in explosives from experimental data is a task that requires a great deal of care, patience, and curve fitting. The authors have found that by measuring more quantities than are mathematically necessary for a complete Lagrange analysis, curve fits to experimental data do not have to be as exacting as otherwise required. An experimental technique is presented that is specifically designed for the determination of global reaction rates which uses both embedded electromagnetic impulse and particle velocity gauges. The methods used to efficiently analyze the data, and the results and conclusions reached from several such studies are also presented.

32681 (CONF-850706—Vol.3, pp 987-998) **Lagrange gage studies of detonation in some intermolecular EA based explosives.** Cowperthwaite, M.; Rosenberg, J.T. (SRI International, Menlo Park, CA). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Multiple Lagrange gages were used to record sets of particle velocity histories in detonation waves propagating in baseline EAK, prill-cast EAK and EAKL. Curves of constant particle velocity were constructed from these sets of histories to map the par-

ticle velocity fields in the regions spanned by the gages. The particle velocity fields were found to contain a steady-state zone and an unsteady zone exhibiting properties of nonideal detonation. Chapman-Jouguet (CJ) calculations, based on the premise that these steady-state zones represent the reaction zones in the explosives, led to the assignment of CJ parameters and reaction times to prill-cast EAK and EAKL but not to baseline EAK. Comparison of the structures of these reaction zones and the ensuing unsteady flows leads to the conclusion that aluminum (L) in this EAKL burns both in the reaction zone and in the release wave behind it.

32682 (CONF-850706—Vol.3, pp 999-1008) **Detonation reaction zone studies on TATB explosives.** Seitz, W.L.; Stacy, H.L.; Wackerle, J. (Los Alamos National Lab., NM). 1985. NTIS, PC A11/MF A01. File Number DE86006785.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Interface velocity histories between heterogeneous detonating explosives and transparent windows, separated by a thin (13 μm) aluminum shim, have been obtained with an image-intensified rotating-mirror streak camera and a Fabry-Perot velocity interferometer system. Seven TATB-based explosives were studied with PMMA windows for typically three charge lengths. Two of the explosives were also studied with LiF windows. In each case a nonsteady detonation was observed, with each increasing charge length showing a corresponding increase in the interface velocity histories. Time resolution and velocity error are estimated to be about 6 ns and 2% respectively. Numerical simulations for one of the explosives, for which a shock-strength modified Arrhenius rate law (DAGMAR) and an assumed equation of state (HOM) had been previously calibrated with shock initiation gauge data, gave good agreement with the experimental velocity histories.

32683 (CONF-850706—Vol.3, pp 1009-1012) **New approach for studying the expansion of detonation products.** Steinberg, D.; Chau, H. (Lawrence Livermore National Lab., CA). 1985. NTIS, PC A11/MF A01. File Number DE86006785. Contract W-7405-ENG-48.

From 8. international symposium on detonation; Albuquerque, NM, USA (15 Jul 1985).

Single crystal 100 LiF has well known mechanical and optical properties. Consequently, it has been used for many years as a window when studying inert materials via the velocimeter technique. Because of its close impedance match to detonating HE, this technique was used to probe the expansion of detonation products. The data on LX14 clearly show the Von Neumann spike as well as many other structures not yet identified. The best estimate for the CJ pressure is 35.3 GPa.

32684 (CONF-860739—1) **Improved high-temperature percussion primer.** Durand, N.A.; Weinmaster, R.R.; Massis, T.M.; Fleming, W. (Sandia National Labs., Albuquerque, NM (USA); Unidynamics, Phoenix, AZ (USA)). 1986. Contract AC04-76DP00789. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009855.

From 11. international pyrotechnics seminar; Vail, CO, USA (7 Jul 1986).

A study was conducted to develop a percussion primer mix that would be capable of functioning after a 20-hour exposure at 200°C. A total of 16 mixes were studied, of which 6 were chosen for basic thermal and chemical properties. All mixtures were thermally evaluated with the differential scanning calorimeter (DSC) and showed no exothermic activity below 250°C. The mixtures were further evaluated by impact and friction sensitivity. Two of the candidate mixtures were selected for further development of a high-temperature, hermetically sealed percussion primer. These were $KClO_3/Sb_2S_3/CaSi_2$ and $KClO_3/Sb_2S_3/CaSi_2$/HNS. The primer mixes were loaded into conventional hardware and subjected to ball-drop sensitivity testing. These two mixes have similar mean sensitivity of approximately 30 in. oz. which are well within the design requirements of 60 in. oz. The hermetically sealed primer that is being developed uses a stainless steel cup, anvil, and sealing ring with a glass-to-metal seal in the output hole. This primer has no reconsolidation requirements, and the sensitivity of this percussion primer is comparable with other commercial primers which are not hermetically sealed. 6 refs., 6 figs., 8 tabs.

32685 **Supercritical fluid phase separations: Implications for detonation properties of condensed explosives.** Ree, F.H. (University of California, Lawrence Livermore National Laboratory, Livermore, California 94550). *Journal of Chemical Physics;* 84: No. 10, 5845-5856(15 May 1986).

High explosive experiments offer the most extensive data on mixtures at high pressures (>10 GPa = 100 kbar) and high temperatures (>1000 K). We have computed the detonation properties of two explosives, PBX-9404 (C/sub 1.4/H/sub 2.75/N/sub 2.57/O/sub 2.69/Cl/sub 0.03/P/sub 0.01/) and PETN ($C_5H_8N_4O_{12}$), using reliable statistical mechanical theories and realistic intermolecular potentials. The composition of the chemical species is determined by minimizing the Gibbs free energy. The calculation shows that the detonation products of explosives containing C, H, N, and O atoms can separate into N_2-rich and N_2-poor fluid phases and that this gas—gas phase separation can affect detonation properties at some pressures and temperatures. Since N_2, CO_2, and H_2O molecules are major detonation products, we made a separate study on binary (N_2—H_2O, CO_2—H_2O, N_2—CO_2) and ternary (N_2—CO_2—H_2O) mixtures. The results of this study show that the N_2—H_2O system may exhibit a fluid phase separation at pressures and temperatures relevant to a detonation environment. The predicted phase separation boundary is sensitive to the N_2—H_2O interaction and to the addition of CO_2 molecules. We suggest static and dynamic experiments on N_2—H_2O mixtures that should reveal whether the predicted fluid phase separation occurs and that will help us refine the N_2—H_2O interaction potential.

4502 Nuclear

REFER ALSO TO CITATION(S) 32742, 32766

32686 **Blast induced subsidence in the craters of nuclear tests over coral.** Burton, D.E.; Swift, R.P. (Lawrence Livermore National Lab., CA). pp 999-1006 of Research and engineering applications in rock masses. Volume 2. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—). Contract W-7405-ENG-48.

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

The craters from high-yield nuclear tests at the Pacific Proving Grounds are very broad and shallow in comparison with the bowl-shaped craters formed in continental rock at the Nevada Test Site and elsewhere. Attempts to account for the differences quantitatively have been generally unsatisfactory. The authors have for the first time successfully modeled the Koa Event, a representative coral-atoll test. On the basis of plausible assumptions about the geology and about the constitutive relations for coral, we have shown that the size and shape of the Koa crater can be accounted for by subsidence and liquefaction phenomena. If future studies confirm these assumptions, it will mean that some scaling formulas based on data from the Pacific will have to be revised to avoid overestimating weapons effects in continental geology.

4503 Explosion Detection

32687 **(BARC—1240) Research and development activities of the Seismology Section for the period January 1982-December 1983.** Roy, F. (Bhabha Atomic Research Centre, Bombay (India)). 1984. 36p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702036.

The research and development activities of the Seismology Section of the Bhabha Atomic Research Centre (BARC) at Bombay are reported for the period January 1982-December 1983 in the form of summaries. The Section's activities are mainly directed towards detection of underground nuclear explosions. During the report period 64 signals out of about 12000 seismograms which were examined were identified as the signals due to underground nuclear explosions. The instrumentation work for Kolar rockburst research was almost completed under the collaboration programme of BARC with Bharat Gold Mines Ltd. Analytical methods have been developed for interpreting the frequency-magnitude relation of earthquake. These methods will be useful in the seismic estimation of risk in case only restricted data involving events of low magni-

tude are available. A list of publications of the staff-members of the Section during the report period is given.

32688 **(UCID—20704-Vol.1) Comprehensive Test Ban Treaty seismic verification decision analysis computer model. Volume 1.** Strait, R.S.; Sicherman, A. (Lawrence Livermore National Lab., CA (USA)). Mar 1986. Contract W-7405-ENG-48. 79p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86009936.

This report provides technical documentation for the Comprehensive Test Ban Treaty seismic verification decision analysis computer model. Volume 1 includes descriptions of the model structure, its major assumptions, the required input, and illustrative output data. Volume 2 contains the computer program. The report is intended primarily for analysts working with the model who are generally familiar with its purpose and how it is applied in a decision analysis. The seismic verification decision analysis computer model evaluates the benefits and costs of in-country seismic monitoring systems for verifying compliance with a Comprehensive Test Ban Treaty. The model can analyze a specific Regional Seismic Verification System (RSVS) design or deployment option as well as compare alternative configurations.

32689 **(UCID—20704-Vol.2) Comprehensive Test Ban Treaty seismic verification decision analysis computer model. Volume 2.** Strait, R.S.; Sicherman, A. (Lawrence Livermore National Lab., CA (USA)). Mar 1986. Contract W-7405-ENG-48. 58p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86009930.

This report provides technical documentation for the Comprehensive Test Ban Treaty seismic verification decision analysis computer model. Volume 2 contains the computer program. Volume 1 includes descriptions of the model structure, its major assumptions, the required input, and illustrative output data. The report is intended primarily for analysts working with the model who are generally familiar with its purpose and how it is applied in a decision analysis. The seismic verification decision analysis computer model evaluates the benefits and costs of in-country seismic monitoring systems for verifying compliance with a Comprehensive Test Ban Treaty. The model can analyze a specific Regional Seismic Verification System (RSVS) design or deployment option as well as compare alternative configurations.

50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC

32690 **Remote sensing; Proceedings of the meeting, Arlington, VA, May 1, 2, 1984.** Slater, P.N. Bellingham, WA; International Society for Optical Engineering (1984). 159p. (CONF-8404124—).

From SPIE technical symposium; Arlington, VA, USA (29 Apr 1984).

The subjects investigated are related to modeling studies, atmospheric effects and radiometric calibration, marine and geological research, spectral signature studies, agricultural research, information extraction and processing, engineering and mapping considerations, and future prospects. Attention is given to a review of models and measurements of multispectral reflectance by plant canopies with recommendations for future research, electrooptical terrain reflectance modeling, atmospheric effects on remote sensing of surface reflectance, the importance and attainment of accurate absolute radiometric calibration, remote sensing of coastal and ocean properties, and high spectral resolution remote sensing of the land. The remote sensing of vegetation at regional scales is considered along with the remote sensing of vegetation characteristics for farm management, the interpretation of topographic relief from digital multispectral imagery, remote sensing research, mapping the earth from space in the 1980s, and the future of remote sensing according to a viewpoint from industry.

5001 Basic Studies

REFER ALSO TO CITATION(S) 32146, 32147, 32149, 32150

32691 **(Juel-Spez—329) Is a rise in global temperature due to the increasing atmospheric CO_2 content predictable.** Doetsch, H. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorbauelemente). Aug 1985. 30p. (In German). NTIS (US Sales Only), PC A03/MF A01. File Number DE86752023.

This is to point out the causal chain making possible a conclusion from carbon dioxide content of the atmosphere to climate. The author concentrates especially on the causal connexion between atmospheric carbon dioxide content and earth surface temperature. Since the evaluation by measurement of such as link is not possible, this connexion has to be derived on the basis of calculation models. It is shown that only a small part of this temeprature increase can be related directly to the infrared activity of carbon dioxide. (orig./PW).

32692 **(NUREG/CR—4113) Flow and dispersion near clusters of buildings.** Hosker, R.P. Jr.; Pendergrass, W.R. (National Oceanic and Atmospheric Administration, Oak Ridge, TN (USA). Air Resources Labs.). Mar 1986. 107p. NTIS, PC A06/MF A01 - GPO. File Number TI86901264.

A brief summary of the flow patterns expected near isolated simple buildings is reviewed. Flow patterns associated with varying densities of uniformly sized buildings in an extensive array are then discussed. A systematic study of near-ground-level flow patterns within simple building clusters is summarized. The suite of presently available models for estimating near-building and wake concentrations is briefly described. It appears to be possible to arrive at rough concentration estimates close to buildings only in cases where one building of a cluster is dominant in size, or within an extensive array of similarly-sized structures. The recent literature suggests that several models developed for single-building intermediate and far wake concentration estimates are also useful for building clusters; the appropriate model depends on whether the effluent source is in the near wake region at ground level, or is a roof-mounted vent, or is a roof-mounted stack of typically modest size. Problems associated with very wide buildings and with cases when the wind approaches at an angle to the buildings are described, and some possible remedial steps are suggested. Additional work is needed in several areas to improve present understanding and to provide better guidance to the practitioner; research recommendations are therefore included.

32693 **(SAND—86-0428C) Minor scale weather-watch and microbarograph project experiments 8620, 9415, 9416.** Reed, J.W.; Church, H.W. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 141p. (CONF-860285—1). NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86009641.

From Minor scale symposium; Albuquerque, NM, USA (24 Feb 1986).

Predictions and measurements of distant airblast propagations were made to identify, control, and document the environmental impact from this large explosion. Special meteorological observations were made to support this as well as other experiments. Rawinsonde balloon upper-air observations were made to about 30 km altitude. Pilot balloons were tracked by optical theodolite to give frequent wind observations to about 3 km above ground. A Tethersonde balloon was operated to give details on atmospheric structure below about 3 km. Rocketsondes were launched to measure temperature and wind conditions at 35- to 65-km heights, for explaining long range airblast propagations that focus near 200 km distance. A meteorological towere was set up at the Admin Park to give continuous records of wind and temperature at three levels to 23 m height. An anemometer was installed near Ground Zero for reference during wind-sensitive helium bag operations. A weather advisory service was established, using WSMR observations as well as national weather data collections, and communicating through a computer terminal at the Stallion Radiosonde Station. Microbarograph (MB) airblast pressure recorders were operated at thirteen locations, from 3 km to 225 km from GZ. During the 10 days preced-

ing MINOR SCALE, 31 ANFO charges, of 250 lb or 2500 lb yields, were fired to document the long range airblast propagation with MB recordings and upper air weather observations.

32694 **(SRD-R—355) Comparison between data from the Thorney Island heavy gas trials and predictions of simple dispersion models.** Wheatley, C.J.; Prince, A.J.; Brighton, P.W.M. (UKAEA Safety and Reliability Directorate, Culcheth). Feb 1986. 91p. United Kingdom Atomic Energy Authority, Wigshaw Lane, Culcheth, Warrington, England WA3 4NE. File Number TI86901292.

Predictions of a number of simple heavy gas dispersion models are compared with area-averaged concentrations derived from the concentration data obtained at Thorney Island during the Phase I trials. The comparison is quantitative, using a number of goodness-of-fit measures. Optimum values of entrainment constants are found for a variety of alternative models of entrainment. For a given trial, it is found that the optimum values are well determined and are consistent between alternative goodness-of-fit measures. Implications for the validity of the alternative models are drawn.

32695 **(UCRL—15755) Contributions to Large-Eddy Simulation. Part 1.** Ohmstede, W.D. (Ohmstede (William D.), Las Cruces, NM (USA)). Dec 1985. Contract W-7405-ENG-48. 29p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86009710.

The purpose of this report is to bring to a close the contributions in support of the Large-Eddy Simulation (LES) project. Major progress has been made. The report UCRL-92457 entitled "Planetary Boundary Layer Structure Derived from Large-Eddy Simulation for Benchmark Stability Categories" [Cederwall, et al (1985)], and the presentation of this material at the Seventh Symposium on Turbulence and Diffusion, 12-15 November 1985 at Boulder, Colorado, constitute completion of major milestones. This report now looks to the future and recommends the next actions which should be taken to promote orderly progress within the project.

32696 **(UCRL—15769) Data bases for isolating the effects of the increasing carbon dioxide concentration.** Bradley, R.S.; Jones, P.D. (Massachusetts Univ., Amherst (USA); East Anglia Univ. (UK)). 1985. Contract W-7405-ENG-48. 25p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009709.

The history of instrumentally recorded temperature data is discussed and some of the limitations of the data and the methods used in deriving large-scale averages reviewed. Long-term precipitation and pressure data sets and their limitations are also discussed. Finally, data on volcanic aerosol loading of the atmosphere and solar irradiance variations are discussed. (ACR)

32697 **(UCRL—15776) Long-term changes in precipitation patterns.** Barnett, T.P. (Scripps Institution of Oceanography, San Diego, CA (USA)). 1985. Contract W-7405-ENG-48. 14p. NTIS, PC A02. File Number DE86009705.

The state of knowledge about large-scale patterns of precipitation is briefly summarized. Available precipitation data and some associated measurement problems are described. Studies of regional precipitation changes since the turn of the century are reviewed. (ACR)

32698 **(UCRL—15778) Challenge of detecting climate change induced by increasing carbon dioxide.** Gates, W.L.; MacCracken, M.C. (Oregon State Univ., Corvallis (USA). Climatic Research Inst.; Lawrence Livermore National Lab., CA (USA)). 1985. Contract W-7405-ENG-48. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009704.

The framework that provides the basis for efforts to detect the climatic effects of increasing CO_2 concentrations is discussed. As background, some of the characteristics of climate, how it has changed, and some of the factors that may play a role in inducing such changes are reviewed. This overview also introduces some of the terminology used in CO_2-climate studies. (ACR)

32699 **(UCRL—15783) Modeling as a means of studying the climate system.** Gates, W.L. (Oregon State Univ., Corvallis (USA). Climatic Research Inst.). 1986. Contract W-7405-ENG-48. 24p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009702.

This report on climate modeling includes the following areas of discussion: (1) the climate system and climate change; (2) the physical basis of climate models; (3) general circulation models of the atmosphere; (4) models of the ocean, ice, and land surface; (5) climate simulation with atmospheric general circulation models; and (6) critical modeling problems and recommended research. (ACR)

32700 **(UCRL—15789) Validation of General Circulation Model (GCM) control runs.** Santer, B.D.; Wigley, T.M.L. (East Anglia Univ. (UK). School of Environmental Sciences). Jan 1986. Contract W-7405-ENG-48. 136p. NTIS, PC A07/MF A01; 1; GPO Dep. File Number DE86009697.

The simulation performance of three General Circulation Models (GCMs) is examined in a North American/European study area (20°N-85°N; 180°W-60°E). Mean sea level (m.s.l.) pressure fields simulated by the OSU two-layer AGCM (fixed SST experiment), the GISS nine-layer AGCM, and the synchronously-coupled OSU CGCM are compared with observed data, and the significance of differences between observed and simulated m.s.l. pressure distributions is assessed using simple grid-point t-tests and spatial field correlations. Objective indices have been developed which are physically relatable to the properties of quasi-stationary surface ridges and trough. These indices have been used to test whether the models are capable of reproducing important features of the observed seasonal cycles of Iceland Low and Azores High intensity and position. Such objective diagnostic tests enable quantitative analysis of inter-model differences in center of action intensity and location, and are also useful in evaluating the effects of changes in grid resolution, ocean representation, or parameterizations on stationary wave properties at the surface. it is demonstrated that detailed regional examination of model performance is justifiable, even given the spatial resolution of currently operational models, and may provide important diagnostic information for modeling groups.

32701 **(UCRL—93771) Comparisons of meteorological and structure parameters in complex terrain.** Porch, W.; Rosen, L.; Neff, W. (Lawrence Livermore National Lab., CA (USA); National Oceanic and Atmospheric Administration, Boulder, CO (USA). Wave Propagation Lab.). Nov 1985. Contract W-7405-ENG-48. 7p. (CONF-860565—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86006713.

From International conference on optical and millimeter wave propagation and scattering in the atmosphere; Florence, Italy (27 May 1986).

Measurements of the temperature and index-of-refraction structure parameters are presented using a variety of instruments with different spatial averaging characteristics in complex terrain nocturnal drainage wind conditions.

32702 **Comparison of numerical pseudodiffusion and atmospheric diffusion.** Sheih, C.M.; Ludwig, F.L. (Argonne National Lab., IL). *Atmospheric Environment;* **19**: No. 7, 1065-1068(1985).

Some numerical pseudodiffusions reported in the literature were compared with atmospheric diffusion for urban to regional scale modeling. For grid sizes of 0.5 and 5 km, such as are used in urban and mesoscale modeling, most of the numerical schemes produced numerical diffusion smaller than natural diffusion. However, for 50 km grid sizes like those used in regional models, about half of the numerical schemes produced artificial diffusion larger than natural diffusion.

32703 **Air pollutant trajectories in precipitating storms.** Michael, P.; Hales, J.M. pp 111-118 of Meteorological aspects of acid rain. Bhumralkar, C.M. (ed.). Boston, MA; Butterworth Publishers (1984). Contract AC02-76CH00016.

A brief discussion of convective and frontal storms is presented. The sensitivity of source/receptor relationships to the as-

sumptions made in the calculation of trajectories is illustrated by showing the results of pollutant transport calculations for two events in which precipitation associated with frontal systems was collected and chemical composition was measured. Two different sets of assumptions were used; the analyses were carried out at BNL and Cornell University. The results fall into two broad categories: the default method for calculating the transport layer and the trajectories calculated with the top of the transport layer at 1000 m give trajectories that reach the area from the northwest - air parcels traveling through northeastern Pennsylvania, extreme western New York, Michigan, and Canada. Trajectories calculated using transport layers above 1800 m run from the southwest through southern Pennsylvania, West Virginia and the Ohio River Valley. 5 references, 3 figures.

32704 **Eddy correlation calculations done in real-time.** McMillen, R.T. (National Oceanic and Atmospheric Administration, Oak Ridge, TN). pp 111-114 of Seventh conference on fire and forest meteorology. Boston, MA; American Meteorological Society (1983).

From 7. conference on fire and forest meteorology; Ft. Collins, CO, USA (26-28 Apr 1983).

A pilot study was conducted at the Walker Branch Watershed site to assess the feasibility of collecting representative turbulent flux data. The absence of scatter in the data and the close agreement between the values of turbulence parameters with those of other researchers indicate that one can calculate stable turbulence parameters by performing a coordinate rotation on the anemometer data after the data are collected. A viable means of computing turbulent variances and covariances on a real-time basis was demonstrated with good results. The quantity of primary interest, u'w', is very stable and is an excellent approximation of the value obtained by the more conventional means. 5 references, 4 figures.

32705 **Determining depths of drainage winds.** Wolfsberg, D.G.; Clements, W.E. (Los Alamos National Lab., NM). pp 121-122 of Sixth symposium on turbulence and diffusion. Boston, MA; American Meteorological Society (1983).

From 6. symposium on turbulence and diffusion; Boston, MA, USA (22-25 Mar 1983).

The depth of drainage winds is a poorly defined concept. Three methods are commonly used to determine the depth of the drainage layer from vertical profiles of meteorological data. There are a shift in wind direction, the top of the surface based inversion, and the velocity minimum above the surface layer jet. Analysis of vertical profiles which were amenable to the application of all three methods suggest the following: a definite wind shift from down-valley directions is the best measure of drainage wind depths regardless of type. In the case of undeterminable wind shifts the height of the velocity minimum appears to be the best measure of depth. Although the presence of a surface inversion is a necessary condition for the types of flows discussed, its depth doesn't appear to be as reliable in estimating the flow depth as the other two methods. There appears to be a stronger correlation between all three methods the simpler the drainage flow situation. 2 references, 1 figure.

32706 **Comparison of radiation fluxes in a fully-leafed and leafless deciduous forest.** Matt, D.R.; Baldocchi, D.D.; Hutchison, B.A.; McMillen, R.T. (National Oceanic and Atmospheric Administration, Oak Ridge, TN). pp 200-203 of Sixth conference on biometeorology and aerobiology. Boston, MA; American Meteorological Society (1983).

From 6. conference on biometeorology and aerobiology; Ft. Collins, CO, USA (25 Apr 1983).

A description is presented of a measurement facility for characterizing the radiation regime in a deciduous forest, along with some results of experimental measurements. The spatial mean daily penetration of radiant flux expressed as a fraction of the incident above-canopy allwave flux was reported for clear days for fully-leaved and leafless forests. The electromagnetic wavebands studied include the shortwave, PAR, allwave, and net allwave. The extinction coefficients for the fully leafed forest were found to be independent of solar elevation, with the coefficient for PAR being significantly different from that for the shortwave and net allwave. 7 references, 2 figures, 3 tables.

5002 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 31314, 31344, 31345, 31372, 31373, 31394, 31395, 31403, 31780, 31781, 31784, 31785, 31786, 31981, 31986, 32089, 32113, 32131, 32132, 32178, 32327, 32370, 32518, 32696, 32698, 32750, 32758, 32778, 32781, 32784

32707 **(CONF-851027—10) Cost-effective monitoring of mixtures of volatile organic compounds (VOC) in residences.** Gammage, R.B. (Oak Ridge National Lab., TN (USA)). 1985. Contract AC05-84OR21400. 35p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86008889.

From 24. Hanford life sciences symposium on health and environmental research on complex organic mixtures; Richland, WA, USA (21 Oct 1985).

Volatile organic compounds (VOC) in indoor air are an important and inescapable component of everyone's exposure to complex mixtures of organics. A tiered approach is outlined for the cost-effective monitoring of VOC. At the coarsest level, a hand-held, direct-reading photoionization detector (PID) is suitable for rapid screening, or following temporal changes if the concentrations are high enough. Readings can be expressed as benzene, or some other VOC, equivalent units. Moderately sophisticated measurements can be made in near real time using a portable GC with a PID. Several of the more abundant hydrocarbons, such as benzene, toluene, and straight and branched chain alkanes are usually measurable in indoor air samples. Passive monitoring devices based on Tenax GC sorbent show promise for the future. The sophisticated method of choice for the collection and definitive analysis of VOC is sorbent trapping on Tenax GC and carbonaceous resins with subsequent thermal desorption and analysis by selected-ion mass spectroscopy. Measurements made inside homes in East Tennessee show that overall levels of VOC are usually in the range of a few tenths to a few mg/m^3. Gasoline fumes are a major component of the VOC, especially where the house has an attached garage. Chlorinated alkanes and alkenes comprise a smaller fraction of the total VOC, usually being present at sum concentrations of a tenth of a mg/m^3 or less. In all types of measurement it was verified that indoor concentrations of VOC exceed those found outdoors.

32708 **(CONF-860426—1) Indoor pollutants in 70 houses in the Tennessee Valley Area: study design and measurement methods.** Dudney, C.S.; Matthews, T.G.; Dreibelbis, W.G.; Hawthorne, A.R.; Thompson, C.V.; Monar, K.P.; Quillen, J.L.; Hjelmfelt, A. (Oak Ridge National Lab., TN (USA); Pennsylvania State Univ., University Park (USA); Northwestern Univ., Evanston, IL (USA)). 1986. Contract AC05-84OR21400. 19p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009506.

From Symposium on measurement of toxic air pollutants; Raleigh, NC, USA (27 Apr 1986).

Levels of nitrogen dioxide, formaldehyde, vapor-phase polynuclear aromatic hydrocarbon compounds, respirable particles, radon and other parameters related to indoor air quality are being measured with passive monitors in a year-long study of indoor air quality in 70 houses in the Tennessee Valley area. Criteria for house selection included presence of a lower level with cement floor and one or more block walls in contact with the soil and proximity to one of four cities in the region (Knoxville, Chattanooga, Birmingham, and Florence). By design, most of the houses in the study are in the same neighborhood as at least one other house in the study. Houses range in age from newly constructed to about forty years old, typically have more than 2000 square feet of finished floor space, and encompass a garage in the lower level in most cases. Six houses near Knoxville were especially selected for intensive study. An instrumented measurement and data acquisition system were used during the summer of 1985 to make a nearly continuous record of oxides of nitrogen, oxides of carbon, formaldehyde, particulate matter, ozone, air exchange rate, and air movement. Simultaneously, passive monitors identical to those used throughout the study were deployed with increased replication in the houses.

32709 (CONF-860606—1) Experimental protocol and preliminary results of air infiltration rate measurements in Tennessee Valley homes. Hawthorne, A.R.; Dudney, C.S.; Matthews, T.G.; Monar, K.P.; Quillen, J.L. (Oak Ridge National Lab., TN (USA); Tennessee Univ., Knoxville (USA)). 1986. Contract AC05-84OR21400. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86008496.

From Air Pollution Control Association annual meeting and exhibition; Minneapolis, MN, USA (22 Jun 1986).

The principal objective of this multipollutant indoor air quality study focuses on measurement of radon and radon progeny. Details of the radon monitoring component and the chemical pollutant monitoring aspects of the study and associated experimental methods have been recently described. Seventy houses throughout the Tennessee Valley area are included in the study. Six houses are in Oak Ridge, Tennessee; nine houses are in Chattanooga, Tennessee; five houses are in Rossville, Georgia (near Chattanooga); four houses are near Tupelo, Mississippi; eight houses are near Florence, Alabama; eight houses are in Huntsville, Alabama; and thirty houses are in the Birmingham, Alabama, area. Ten of the thirty houses in Birmingham are "energy efficient" houses as defined by the local utility conservation program. With the exception of some of the energy efficient houses in Birmingham, all other houses have a basement level and a living space above this level. Some houses have this lower level as a conditioned living space; others do not. Only houses with basement levels were included in the main component of the study due to design objectives related to radon monitoring. Ten "energy efficient" houses were added to the originally selected 60 houses to allow comparison between these homes and more typical houses in the study.

32710 (CONF-8603107—1) Modeled trends and climatological variability of the net transboundary mass flux of airborne sulfur between the United States and Canada. Shannon, J.D.; Lesht, B.M. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009188.

From 2. international specialty conference on meteorology of acid deposition; Albany, NY, USA (17 Mar 1986).

If the mass budget of anthropogenic sulfur oxides over a large source region is examined in a broad perspective, there are three possible pollutant fates. The sulfur can be deposited within the region by wet processes, deposited by dry processes, or exported from the region. Only wet deposition is monitored on a scale sufficient to make estimates of the integrated deposition across a region. Dry deposition is measured only at a few research sites and is not directly monitored on regional scales, while net mass export has been measured only on a fragmentary basis (Galloway et al., 1984). Thus, we must depend primarily upon simulation models for our estimates of integrated dry deposition and long-term net mass export. In this paper we use a simulation model to examine the net mass flux of pollutant sulfur from both the United States and Canada, with particular emphasis on transport across their common border. We estimate its seasonal and annual variability for the period 1976 to 1981, and compare the contribution from emission changes with the contribution from year-to-year changes in climatology in producing that variability. Estimates of the horizontal net mass fluxes of sulfur oxides are useful for (1) testing the internal consistency of simulation models of atmospheric pollutant transport and deposition; (2) indirect estimation of integrated dry deposition totals as the residual when integrated wet deposition and net export are subtracted from total emissions; and (3) evaluation of the importance of the total emissions within a region compared to the net influx from outside sources.

32711 (DOE/ER/60006—4) Chemical reactivity of polycyclic organic compounds adsorbed on coal fly ash and related solid surfaces. Progress report, May 1985-April 1986. Mamantov, G.; Wehry, E.L. (Tennessee Univ., Knoxville (USA). Dept. of Chemistry). Apr 1986. Contract AS05-81ER60006. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010293.

The fundamental objectives of this research are to characterize and understand the photochemical and nonphotochemical reactivity of polycyclic aromatic hydrocarbons (PAHs) and their derivatives as adsorbates on the surface of coal fly ash and related particulate solids. Specific efforts undertaken and results obtained during this period are summarized with detailed discussions presented in the form of Appendices. Results are tabulated from a thorough examination of the photochemistry of pyrene, benzo[a]pyrene (BaP), anthracene, phenanthrene, and benz[a]anthracene (BaA) as adsorbates on eight coal stack ashes. A procedure was developed to separate coal ashes into carbon and iron contents. Attempts to measure heats of absorption of PAHs on various coal ashes were made. Pyrene nitration occurred only when NO_2 was contaminated with nitric acid.

32712 (IEA/ICTIS/TR—30) Sulphates in the atmosphere. Harter, P. (International Energy Agency Coal Research, London (UK)). Nov 1985. 152p. NTIS (US Sales Only), PC A08/MF A01. File Number TI86901136.

This review covers the atmospheric processes involving sulfates, from emission of sulphur dioxide to deposition of sulfates, and the direct effects of atmospheric sulfates. The global sulphur cycle is examined to determine the magnitude of natural and man-made sulphur emissions and to outline the pathways of sulphur species through the environment. The atmospheric reactions of sulphur from the reduced to the fully oxidized states are treated with emphasis on the possible mechanisms of sulphur dioxide oxidation to the sulphate ion and sulphuric acid, including aerosol particle formation. Concentrations of sulphate aerosol in the atmosphere and aerosol transport processes in the medium- and long-range are outlined. Dry, occult and wet deposition are investigated, including historical trends in precipitation chemistry. The results of mathematical modeling of transport and deposition processes are briefly examined. Possible atmospheric effects of sulfates are outlined, covering effects on visibility, climate, materials and direct health effects on humans, with special reference to respiratory effects. Although mathematical models have not been shown to predict accurately the effects of alternative control strategies on sulphur deposition patterns it is quite clear that reducing sulphur dioxide emissions would reduce the total deposition of sulphur. The only direct effect which can be attributed to atmospheric sulfates at present day ambient concentrations is reduction of visibility in some areas. The association of secondary sulfates with visibility reduction could possibly widen the geographical spread of combustion plants affected by the pressure for reduction of sulphur dioxide emissions. 602 refs.

32713 (LBL—17598-Rev.) Evaluation of indoor aerosol control devices and their effects on radon progeny concentrations. Revision. Sextro, R.G.; Offermann, F.J.; Nazaroff, W.W.; Nero, A.V.; Revzan, K.L.; Yater, J. (Lawrence Berkeley Lab., CA (USA)). Nov 1984. Contract AC03-76SF00098. 22p. (EEB-Vent—84-13; CONF-840803—8-Rev.). NTIS, PC A02/MF A01; GPO Dep. File Number DE86009367.

From 3. international conference on indoor air quality and climate; Stockholm, Sweden (20 Aug 1984).

Eleven portable air cleaning devices have been evaluated for control of indoor concentrations of respirable particles, and their concomitant effects on radon progeny concentrations have been investigated. The experiments were conducted in a room-size chamber using cigarette smoke and radon injection from an external source. Of the devices examined the electrostatic precipitators and extended surface filters had significant particle removal rates, while the particle removal rates for several small panel-filters, an ion-generator, and a pair of mixing fans were found to be essentially negligible. The evaluation of radon progeny control produced similar results; the air cleaners which were effective in removing particles were also effective in reducing radon progeny concentrations. At the low particle concentrations, deposition of the unattached radon progeny on room surfaces was found to be a significant removal mechanism. Deposition rates of attached and unattached progeny have been estimated from these data, and were used to calculate the equilibrium factors for total and unattached progeny concentrations as a function of particle concentration. While particle removal reduces total airborne radon progeny concentrations, the relative alpha decay dose to the lungs appears to change very little as the particle concentration decreases due to the greater radiological importance of unattached progeny.

32714 **(ORNL/M—143) CDIC communications.** Fowler, D.E. (ed.). (Oak Ridge National Lab., TN (USA)). Spr 1986. Contract AC05-84OR21400. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009956.

This semi-annual newsletter includes information on new publications, presents summaries of research on atmospheric CO_2 concentrations measured in ice cores and on estimating terrestrial biospheric CO_2 release from the tropics, book and symposium reviews, a list of numeric data packages, citations to the open literature on carbon dioxide effects, and a list of upcoming CO_2-related meetings. (ACR)

32715 **(PB—86-155256/XAB) Chemical emergency preparedness program: organizing the community, gathering site-specific information, contingency plan development, contingency plan appraisal, the criteria, appendices. Interim guidance.** (Environmental Protection Agency, Washington, DC (USA)). Nov 1985. 171p. NTIS, PC A08/MF A01.

The document, developed by the U.S. Environmental Protection Agency (USEPA) is part of the USEPA National Air Toxics Strategy. The purpose of the document is to provide the public and state and local officials with information to assist them in planning how to respond to accidental releases of acutely toxic chemicals. It provides recommendations on how communities get organized, gather relavent information, and develop, evaluate and update contingency plans. It also describes the criteria used by the EPA to classify chemicals as acutely toxic and provides a list of 402 chemicals that meet these criteria.

32716 **(PB—86-155264/XAB) Chemical emergency preparedness program: chemical profiles. Interim guidance.** (Environmental Protection Agency, Washington, DC (USA)). Dec 1985. 1435p. NTIS, PC A99/MF A01.

The document, developed by the U.S. Environmental Protection Agency (USEPA) is part of the USEPA National Air Toxics Strategy. The document is provided in support of EPA Chemical Emergency Preparedness Program (CEPP) which deals with accidental release of acutely toxic chemicals. For each acutely toxic chemical listed in the CEPP guidance document (report number PB86-155256), a chemical profile is available. A chemical profile is a collection of information on the chemical identity hazardous identity, physical/chemical characteristics, fire and explosive hazard, reactivity, health hazard, use, and precautions for handling and use of the chemical. The information is presented in the format that conforms as closely as possible to the Occupational Safety and Health Administration (OSHA) recommended format for a Material Safety Data Sheet (MSDS).

32717 **(PB—86-155439/XAB) Field-inspection notebook for monitoring total reduced sulfur (TRS) from kraft pulp mills.** Winberry, W.T. (Engineering-Science, Inc., Durham, NC (USA)). Dec 1984. 109p. NTIS, PC A06/MF A01.

Field-performance audit procedures were developed for three of the most common total reduced sulfur (TRS) continuous-emission-monitoring systems (CEMS). These procedures were designed to assist state/federal field inspectors in the evaluation of TRS-CEMS. Contained in the notebook are checklists and data-entry tables covering preparation for the inspection, preliminary review of records, preliminary on-site meeting with source personnel, and general guidelines for inspection of any type TRS-CEMS. Specific audit procedures for three of the most common models of TRS CEMS: Sampling Technology Inc. Model 100 TRS CEM System; Barton Titrator TRS System; and Bendix Gas Chromatograph TRS System are provided as sectional inserts. In auditing these monitors the inspector should follow the specific procedure rather than the general guidelines given in the body of the field notebook. Conscientious use of this notebook will aid the inspector in conducting a thorough audit of the TRS CEMS and provide a comprehensive original record of all phases of the inspection.

32718 **(PB—86-155645/XAB) Air quality criteria for ozone and other photochemical oxidants. External Review Draft No. 2. Volume 1.** Adams, R.M.; Garner, J.H.B.; Graham, J.A.; Gardner, D.E.; Horstman, D.H. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Nov 1985. 233p. (EPA/600/8—84/020B-1). NTIS, PC A11/MF A01.

Scientific information is presented and evaluated relative to the health and welfare effects associated with exposure to ozone and other photochemical oxidants. Although not intended as a complete and detailed literature review, the document covers pertinent literature through early 1985. Data on health and welfare effects are emphasized, but additional information is provided for understanding the nature of the oxidant pollution problem and for evaluating the reliability of effects data as well as their relevance to potential exposures to ozone and other oxidants at concentrations occurring in ambient air. Information is presented on the following exposure-related topics: nature, source, measurement, and concentrations of precursors to ozone and other photochemical oxidants; formation of ozone and other photochemical oxidants and their transport once formed; properties, chemistry, and measurement of ozone and other photochemical oxidants; and concentrations of ozone and other photochemical oxidants typically found in ambient air. Chapters on health and welfare effects address the toxicological effects of ozone and other oxidants; effects observed in controlled human exposures; effects observed in field and epidemiological studies; effects on vegetation seen in field and controlled exposures; effects on natural and agroecosystems; and effects on nonbiological materials observed in field and chamber studies.

32719 **(PB—86-155652/XAB) Air quality criteria for ozone and other photochemical oxidants. External Review Draft No. 2. Volume 5.** Horstman, D.H.; Horvath, S.M.; Raub, J.A. (Environmental Protection Agency, Research Triangle Park, NC (USA). Environmental Criteria and Assessment Office). Nov 1985. 319p. (EPA/600/8—84/020B-5). NTIS, PC A14/MF A01.

Scientific information is presented and evaluated relative to the health and welfare effects associated with exposure to ozone and other photochemical oxidants. Although not intended as a complete and detailed literature review, the document covers pertinent literature through early 1985. Data on health and welfare effects are emphasized, but additional information is provided for understanding the nature of the oxidant pollution problem and for evaluating the reliability of effects data as well as their relevance to potential exposures to ozone and other oxidants at concentrations occurring in ambient air. Information is presented on the following exposure-related topics: nature, source, measurement, and concentrations of precursors to ozone and other photochemical oxidants; formation of ozone and other photochemical oxidants and their transport once formed; properties, chemistry, and measurement of ozone and other photochemical oxidants; and concentrations of ozone and other photochemical oxidants typically found in ambient air. Chapters on health and welfare effects address the toxicological effects of ozone and other oxidants; effects observed in controlled human exposures; effects observed in field and epidemiological studies; effects on vegetation seen in field and controlled exposures; effects on natural and agroecosystems; and effects on nonbiological materials observed in field and chamber studies.

32720 **(PB—86-156338/XAB) Offset-lithography summary report for technical support in development of a revised ozone State Implementation Plan for Memphis, Tennessee.** (Pacific Environmental Services, Inc., Durham, NC (USA)). Jun 1985. 48p. NTIS, PC A03/MF A01.

The document presents information on emissions of volatile organic compounds (VOC) from offset lithography facilities in Shelby County, Tennessee. Information is presented on the industry, emissions from offset press operations, emission control techniques, and the costs of reducing emissions. The control measures described in the document represent the presumptive norm or reasonably available control technology (RACT) that can be applied to existing-offset lithography plants. Reasonably available control technology is defined as the lowest emission limit that a particular

source is capable of achieving by application of control technology that is reasonably available considering technological and economic feasibility. It may require technology that has been applied to similar, but not necessarily identical, source categories. It is not intended that extensive research and development be conducted before a given control technology can be applied to the source. However, short-term evaluation programs are considered an appropriate technology forcing aspect of RACT.

32721 **(PB—86-156528/XAB) Trace element concentrations on fine particles in the Ohio River Valley.** Tuncel, S.G.; Gordon, G.E.; Olmez, I.; Parrington, J.R. (Maryland Univ., College Park (USA). Dept. of Chemistry). Jan 1986. 16p. NTIS, PC A02/MF A01.

Atmospheric particles were collected from May, 1980 to Dec., 1981 at 3 sampling sites in the Ohio River Valley (ORV). The collected samples were analyzed by x-ray fluorescence (XRF) for elemental concentrations and their masses determined by beta gauging. The XRF data and associated wind trajectories were used to select a subset (200) of ORV samples in the fine fraction for further analysis by instrumental neutron activation analysis (INAA). Combined XRF and INAA data provided concentration values for up to 40 elements. Trace element concentration ratios to Se did not show modal that which were previously observed in samples collected downwind from the Midwest U.S. Chemical mass balances with 11 sources are being used to fit trace-element concentrations. Most particulate S is governed by the regional sulfate component. Results suggest that the distance scale is shorter than previously thought.

32722 **(PB—86-156825/XAB) Solvent extraction: summary report for technical support in development of a revised ozone State Implementation Plan for Memphis, Tennessee.** (Pacific Environmental Services, Inc., Durham, NC (USA)). Jun 1985. 37p. NTIS, PC A03/MF A01.

The document presents information on emissions of volatile organic compounds (VOC) from solvent extraction processing facilities in Shelby County, Tennessee. Information is presented on the soybean and cottonseed oil extraction industry, emissions from solvent-extraction plants, emission-control techniques, and the costs of reducing emissions. Sources of information include: an inspection at a soybean processing plant, a background document prepared by the Illinois Pollution Control Board, EPA publications, literature from the National Soybean Producers Association (NSPA) and National Cottonseed Products Association (NCPA), and discussions with industry representatives. The control measures described represent the presumptive norm or reasonably available control technology (RACT) that can be applied to existing soybean and cottonseed processing plants. Reasonably available control technology for solvent-extraction plants consists of efficient operation of the mineral oil scrubber and desolventizer-toaster, and good engineering practices (e.g., repair of leaking equipment).

32723 **(PB—86-157559/XAB) Barge-loading facilities: summary report for technical support in development of a revised ozone State Implementation Plan for Memphis, Tennessee.** (Pacific Environmental Services, Inc., Durham, NC (USA)). Jun 1985. 35p. NTIS, PC A03/MF A01.

The document presents information on emissions of volatile organic compounds (VOC's) from barge-loading facilities in Shelby County, Tennessee. Information is presented on the process, emissions, emission control techniques, and the cost of reducing emissions based on information from a variety of sources. These sources include: an inspection of a barge loading facility, U.S. Environmental Protection Agency (EPA) documents, technical literature, telephone communications with a representative of the MAPCO barge loading facility, and meetings with EPA personnel. The basis for this information is a status report for demonstration of vapor control technology for gasoline loading of barges.

32724 **(PB—86-158136/XAB) Bulk plants: technical support in development of a revised ozone State Implementation Plan for Memphis, Tennessee. Summary report.** (Pacific Environmental Services, Inc., Durham, NC (USA)). Jun 1985. 31p. NTIS, PC A03/MF A01.

The document presents information on emissions of volatile organic compounds (VOC) from a bulk gasoline plant in Shelby County, Tennessee. The bulk plant is reported to emit less than 25 tons per year of VOC. The results of the analysis are used to identify reasonably available control technology (RACT) for VOC emissions from bulk gasoline plants in Shelby County emitting or showing the potential to emit 25 tons per year or less of VOC. Information presented in the document was obtained from the Union Texas Petroleum bulk gasoline plant in Memphis, Tennessee, the Memphis and Shelby County Health Department permit application files, the 1985 Shelby County VOC emissions inventory, and the Control Techniques Guideline (CTG) Document for Bulk Gasoline Plants. The sections of the report briefly discuss emission sources, emission controls and costs, and operation of the bulk gasoline plant.

32725 **(PB—86-158227/XAB) Fiscal year 1984 program report: Connecticut Institute of Water Resources.** Burke, C.N. (Connecticut Univ., Storrs (USA). Inst. of Water Resources). Sep 1985. 50p. NTIS, PC A03/MF A01.

Alleviation and identification of threats to groundwater supplies was addressed by the following projects: a study of the mechanisms controlling gasoline partitioning and transport in groundwater; chemical and physical studies of adsorption and reactions of hazardous-waste metals and chlorinated hydrocarbons; contribution of toxic chemicals to groundwater from domestic on-site sewage disposal systems. Because of urbanization stress on lakes important to state citizens as well as to tourism, the following projects were funded: 05, Diagnosis of watershed and internal phosphorus loading in Candlewood Lake; and mirrors of the landscape: a guide to diagnosing and managing lake ecosystems.

32726 **(PB—86-160272/XAB) Evaluation of sorbents and additives for dry SO_2 (sulfur dioxide) removal. Report for September 1984-December 1985.** Jorgensen, C.; Chang, J.C.S.; Brna, T.G. (Acurex Corp., Research Triangle Park, NC (USA). Southeast Regional Office). Jan 1986. 28p. NTIS, PC A03/MF A01.

The paper gives results of bench-scale reactivity studies of alkaline sorbents, performed in an integrated fixed-bed reactor, simulating the fabric-filter dust layer of dry flue-gas-desulfurization (FGD) systems. Relative humidity significantly affected SO_2 absorption by lime and limestone plus additives such as $CaCl_2$, $Ca(NO_3)_2$, and $NaNO_3$, but had less impact on $NaHCO_3$ reactivity. Different reaction patterns of various sorbents were observed. Results are discussed relating to sorbent screening for dry FGD systems.

32727 **(PB—86-162104/XAB) Leachate collection and gas migration and emission problems at landfills and surface impoundments. Final report, September 1983-March 1985.** Ghassemi, M.; Crawford, K.; Haro, M. (Multidisciplinary Energy and Environmental Systems and Applications, San Pedro, CA (USA)). Jan 1986. 207p. NTIS, PC A10/MF A01.

Clogging of leachate systems and gas migration and emission problems were evaluated at hazardous-waste landfills and surface impoundments. Collective and preventive measures were identified along with research and development needs. The analysis used literature and information obtained by interviews with experts at 16 design firms, state regulatory agencies, and public organizations. Problems related to leachate collection systems and gas emissions can best be addressed through preventive measures involving design, construction, and operation practices.

32728 **(PB—86-167020/XAB) Evaluation of control technologies for hazardous air pollutants. Volume 1. Technical report. Final report, August 1984-October 1985.** Purcell, R.Y.; Shareef, G.S. (Pacific Environmental Services, Inc., Durham, NC (USA)). Feb 1986. 368p. NTIS, PC A16/MF A01.

The manual is an aid to EPA regional, state, and local air-pollution-control-agency technical personnel in selecting, evaluating, and developing costs of air pollution control techniques for reducing or eliminating the emission of potentially hazardous air pollutants (HAPs) from industrial/commercial sources. It contains information that should be useful for reviewing permit applications or for informing interested parties as to the type, basic design, and

cost of available HAP control systems. Since the definition of a HAP is very broad (encompasses potentially thousands of compounds), it is not possible for the handbook to include an all-inclusive list of HAP compounds and compound-specific control techniques. However, there are only a few available generic air-pollution control-techniques, and the factors affecting their cost and performance as applied to many noncriteria pollutants have been identified and discussed in the literature.

32729 **(PB—86-167038/XAB) Evaluation of control technologies for hazardous air pollutants. Volume 2. Appendices. Final report, August 1984-October 1985.** Purcell, R.Y.; Shareef, G.S. (Pacific Environmental Services, Inc., Durham, NC (USA)). Feb 1986. 294p. NTIS, PC A13/MF A01.

The manual is an aid to EPA regional, state, and local air pollution control agency technical personnel in selecting, evaluating, and developing costs of air pollution control techniques for reducing or eliminating the emission of potentially hazardous air pollutants (HAPs) from industrial/commercial sources. It contains information that should be useful for reviewing permit applications or for informing interested parties as to the type, basic design, and cost of available HAP control systems. Since the definition of a HAP is very broad (encompasses potentially thousands of compounds), it is not possible for the handbook to include an all-inclusive list of HAP compounds and compound-specific control techniques. However, there are only a few available generic air pollution control techniques, and the factors affecting their cost and performance as applied to many noncriteria pollutants have been identified and discussed in the literature.

32730 **(PSI-TR—259/542) Unified projection of the performance and economics of radiation-initiated NO/sub x// SO/sub x/ emission control technologies. Final report.** Person, J.C.; Ham, D.O.; Boni, A.A. (Physical Sciences, Inc., Andover, MA (USA)). Oct 1985. Contract AC22-84PC70259. 162p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86003620.

This report presents the results of a kinetic modeling study of advanced, radiation initiated, SO_2/NO/sub x/ post-combustion control concepts. The concepts studied include: (1) high energy electron beam (e-beam) irradiation, (2) electrical discharge irradiation, and (3) laser or flashlamp irradiation of radical precursor additives. We have assessed performance limits for each of these concepts and evaluated the relative operating costs in terms of their energy efficiencies. These results lead us to recommendations for work that can help develop the e-beam processes to reduce operating costs. We conclude that none of the discharge or photon concepts considered is likely to be sufficiently energy efficient to be useful for post-combustion control. Our objective was to analyze the physical processes involved in each of these concepts, to evaluate technical limits and to understand the commonality and differences of these concepts. We have sought to explain the chemistry of SO_2/NO/sub x/ removal in terms of the simplest, physically realistic mechanism. This can only be accomplished with confidence by evaluating the importance of a large number of reactions in a complex model incorporating all possibly important reactions to fit all available data.

32731 **(TVA/ONRED/AWR—86/11) Second annual acid rain conference for the Southern Appalachians: proceedings. Abstracts.** Olem, H. (ed.). (Tennessee Valley Authority, Chattanooga (USA). Office of Natural Resources and Economic Development). Nov 1985. 68p. (CONF-8510298—Absts.). NTIS, PC A04/MF A01. File Number DE86901133.

From 2. annual acid rain conference for the Southern Appalachians; Gatlinburg, TN, USA (28 Oct 1985).

Individual sessions are listed separately. Abstracts only are provided. (PSB)

32732 **(TVA/ONRED/AWR—86/11, pp 19-36) Concurrent Session I: Terrestrial Effects.** Nov 1985. NTIS, PC A04/MF A01. File Number DE86901133. (CONF-8510298—Absts.).

From 2. annual acid rain conference for the Southern Appalachians; Gatlinburg, TN, USA (28 Oct 1985).

Subjects and leaders were: Assessment of the spruce-fir type in the Southern Appalachians using remotely sensed data - C. Dull, J.D. Ward, and W. Clerke; Spruce-fir research in Great Smoky Mountains National Park: characteristics of upper surface flecking in Picea rubens needles - C. Eagar, P.C. Durr, and L. Richmond; Spruce-fir decline in the Southern Appalachians - E.S. Groton, P.F. Brewer, and J.M. Kelly; SARRMC investigation of stand and site conditions of Southern Appalachian spruce-fir - N.S. Nicholas, S.M.; Zedaker, P.S. White, C.C. Eager, and T.E. Burke; Overview of spruce-fir disturbance history and effects at Mount Rogers National Recreation Area, Great Smoky Mountains National Park, and the Black Mountains - C. Pyle, P.S. White, M.P. Schafale, and T.R. Wentworth; The role of plant-parasitic nematodes in the etiology of spruce-fir decline in the Southern Appalachian mountains - K.M. Hartman and J.D. Eisenback; Testing growth-decline hypotheses using a model of forest development - V.H. Dale; Recent investigations of growth and chemistry of tree rings in the Great Smoky Mountains National Park - C.F. Baes, III, S.B. McLaughlin, and D.S. Lancaster; Investigations of growth and trace metal concentrations in tree rings from Coweeta Hydrologic Station - L. Ragsdale and C. Berish; Tree-ring analysis of growth trends - R.L. Phipps and J.C. Whiton; Mineralogy of some soils in Great Smoky Mountains National Park - D.A. Lietzke; Nutrient exchange between acid rain solutions and leaves of red oak trees growing in soils differing in fertility - T. Leininger and W. Winner; and Modeling the effects of acid rain dose regime on plant populations - R.L. Olson, Jr.

32733 (TVA/ONRED/AWR—86/11, pp 49-55) **General Session.** Nov 1985. NTIS, PC A04/MF A01. File Number DE86901133. (CONF-8510298—Absts.).

From 2. annual acid rain conference for the Southern Appalachians; Gatlinburg, TN, USA (28 Oct 1985).

Speakers and topics for the General Session were: Soil humic substances: contribution to surface water acidity - E.M. Perdue; The chemistry of subsurface flow in a spruce and a hardwood stand - J.D. Joslin, Jr.; Field verification of dry deposition rates and effects in a small watershed - N.E. Peters and J.B. Shanley; Intensive monitoring of deposition and cloud interception at Whitetop Mountain, Virginia - L.M. Reisinger and T.L. Crawford; Direct and inferential measurements of gaseous SO_2 deposition to a forest canopy - T.P. Meyers, D.R. Matt, McMillen, R.T.; Hicks, B.B., Womack, J.D., and D.D. Baldocchi; and Atmospheric deposition monitoring program in Georgia - J.F. Allen.

32734 **(Y/TR—86/1) Report on the meeting held on January 8 and 9, 1986 at Cesta on the discharge of UF_6.** Bourdette, A.; Perrot, J. (Oak Ridge Y-12 Plant, TN (USA); CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). 22 Jan 1986. Contract AC05-84OS21400. Translation of CESTA/EX/ESP. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86008132.

The experimental protocol for an experiment investigating the transport of released plumes of SF_6 and UF_6 were discussed in this report. (ACR)

32735 **Infrared laser long-path measurement of pollutant gas concentrations.** Grant, W.B. (California Institute of Technology, Pasadena). pp 59 of 18th Middle Atlantic Regional Meeting, American Chemical Society. Newark, NJ; New Jersey Institute of Technology (1985). (CONF-8405347—).

From 18. American Chemical Society Middle Atlantic Regional meeting; Newark, NJ, USA (21 May 1984).

The absorption spectra of three hydrazines and four of their air-oxidation products were measured in the 9-12 μm spectral region with a Bomem Fourier transform infrared spectrometer with a 0.05-cm^{-1} resolution in order to determine absorption coefficients at CO_2 and tunable diode laser wavelengths. The measurements agreed well with published CO_2-laser determinations for many of the absorption coefficients, except where the published values are thought to be in error. The coefficients were then used to estimate the sensitivity for remote detection of the gases using CO_2 and tunable diode lasers in long-path differential absorption measurements. Brief mention will also be made of other gases that can be measured using infrared lasers.

32736 **Evaluation of three regional air quality models.** Ruff, R.E.; Nitz, K.C.; Ludwig, F.L.; Bhumralkar, C.M.; Shannon, J.D.; Sheih, C.M.; Lee, I.Y.; Kumar, R.; McNaughton, D.J. (SRI International, Menlo Park, CA). *Atmospheric Environment;* **19**: No. 7, 1103-1115(1985).

This paper summarizes the results of a thorough assessment of existing regional air quality models. Forty-two candidate models were reviewed and three representative models were selected for rigorous and comprehensive assessment. The underlying scientific theories used in the models were evaluated, revealing many limitations. For example, the techniques used in the preparation of meteorological fields that drive the models give insufficient consideration to the physical basis of the relevant atmospheric processes. The primary operational evaluation of each of the models was performed by comparing calculated values with observations from the EPRI Sulfate Regional Experiment (SURE). Both short-term (6-h averages) and long-term (annual averages) comparisons reveal poor correlations for both SO_2 and SO_4^{2-} for the three models evaluated ranging from 0.05 to 0.32 for 3- to 6-h SO_2 concentration to 0.03 to 0.59 for 24-h and monthly averages; in some cases, the correlations are negative. The results also show that calculated concentrations are generally characterized by high biases for 3- to 6-h concentration predictions. Biases tend to be somewhat smaller for monthly averages. All three models underpredicted wet deposition with average normalized residuals of approximately 0.2 for ENAMAP-2, and 0.5 for RTM-II and ACID.

32737 **Air pollution: applications of simple luminescence techniques.** Vo-Dinh, T. pp 257-270 of Identification and analysis of organic pollutants in air. Keith, L.H. (ed.). Boston, MA; Butterworth Publishers (1984). Contract W-7405-ENG-26.

An overview is provided of the principles and applications of two simple spectroscopic methods; synchronous luminescence (SL) and room temperature phosphorescence (RTP). RTP and SL can be used for screening large numbers of unfractionated air samples to obtain a preliminary ranking of polynuclear aromatic (PNA) content. These two techniques can also be utilized for detailed identification and quantification of selected PNA compounds in samples that have been fractionated prior to analysis. The RTP methodology can also be used as a sensitive detection method in a newly developed passive dosimeter that serves as a personnel or area monitor for PNA vapors in the workplace. 15 references, 6 figures, 4 tables.

32738 **Gas-aqueous reactions of sulfur and nitrogen oxides in liquid-water clouds.** Schwartz, S.E. pp 173-208 of SO_2, NO and NO_2 oxidation mechanisms: atmospheric considerations. Calvert, J.G. (ed.). Boston, MA; Butterworth Publishers (1984). Contract AC02-76CH00016.

Clouds, which consist of small, highly dispersed droplets in intimate contact with the surrounding air, provide both a strong thermochemical driving force for reaction of sulfur and nitrogen oxides to form their respective oxyacids and a medium in which this reaction may take place. Reaction rate may be evaluated under the assumption of equilibrium distribution of the reagent gases between the gas-phase and aqueous solution. In this approximation, the reaction rate per unit physical volume is evaluated as the aqueous-phase rate times the liquid-water volume fraction. Readily applicable criteria are presented whereby the assumption of saturation may be tested in terms of the solubility and reaction rate of the reagent gas. Based on the examples treated, this assumption would appear to hold in the great majority of the situations of interest. Rate laws to be employed in evaluation of aqueous-phase reaction rates in clouds derive from laboratory kinetic studies. A major concern in application of laboratory kinetic data available at present in the evaluation of reaction rates in clouds is the lack of confirmatory experiments. Trace constituents might cause departure from the rate laws determined for pure systems as a consequence of positive or negative catalysis. 75 references, 13 figures, 3 tables.

32739 **Portable calculator operating system for aerosol science use.** Carpenter, R.L.; Barr, E.B. (Inhalation Toxicology Research Institute, Albuquerque, NM). *American Industrial Hygiene Association Journal;* **44**: No. 4, 268-272(Apr 1983). Contract AC04-76EV01013.

By employing the capabilities of a programmable calculator, the authors have developed a system of programs that calculates quantities often used in aerosol science. This system is suitable for use in the laboratory or in locations remote from normal laboratory environments and has the capability for executing complex calculations for data analysis from the keyboard in a manner similar to the functions supplied by a calculator manufacturer. Quantities calculated are particle real and aerodynamic diameter; slip correction factor; density, viscosity and mean free path of air at specified temperature and pressure; Reynolds number; particle stopping distance and velocity; as well as cascade impactor jet area and jet velocity. To provide flexibility for diverse data reduction needs, provisions are made to allow the user to write control programs that use the system programs to calculate desired quantities. 9 references. 2 figures, 3 tables.

5003 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 32734, 32848, 33419

32740 **(BARC—1257) Report on R and D activities of Air Monitoring Section (Division of Radiological Protection) 1979-1984.** Mishra, U.C.; Sadasivan, S. (Bhabha Atomic Research Centre, Bombay (India)). 1985. 73p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86702028.

The work done by the Air Monitoring Section of the Bhabha Atomic Research Centre, Bombay, during the period 1979-1984 is reported. The work is reported in the form of programme summaries grouped under the headings: (1) atmospheric radioactivity, (2) biospheric radioactivity, (3) radioactivity monitoring systems, (4) environmental monitoring for trace constituents, (5) pollution monitoring systems, (6) aerosal studies, and (7) atmospheric physics and chemistry. The Section continued to supply continuous in-plant air/water radioactivity monitoring systems and continuous monitoring systems for gaseous constituents to various units of the Department of Atomic Energy. A list of papers published in journals, papers presented at conferences and symposia and technical reports published by the staff-members of the Section is given.

32741 **(EUR—9675) Predicting lift-off of major self-heating releases under the influence of a building.** Benodekar, R.W.; Goddard, A.J.H.; Gosman, A.D. (Commission of the European Communities, Luxembourg). 1985. 174p. NTIS (US Sales Only), PC A08/MF A01. File Number DE86751796.

Turbulent flow around a bluff body poses many problems with respect to both numerical and turbulence modelling. The review of numerical studies made indicates the need for refined numerical treatment such as use of higher order differencing schemes. The 2-D predictions made in the present study represent preparatory work aimed in this direction. The 2-D solution procedure described employs a differencing scheme which simultaneously satisfies the requirements of low numerical diffusion and positivity of coefficients. The effects of turbulence are modelled by a variant of the k-epsilon turbulence model incorporating curvature corrections. The governing equations are solved by an efficient pressure-implicit split-operator algorithm known as PISO. Predictions have been compared with experimental data and previous calculations.

32742 **(LA—10605-MS) Fallout forecasting: 1945-1962.** Kennedy, W.R. Jr. (Los Alamos National Lab., NM (USA)). Mar 1986. Contract W-7405-ENG-36. 41p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86009790.

The delayed hazards of fallout from the detonations of nuclear devices in the atmosphere have always been the concern of those involved in the Test Program. Even before the Trinity Shot (TR-2) of July 16, 1945, many very competent, intelligent scientists and others from all fields of expertise tried their hand at the prediction problems. This resume and collection of parts from reports, memoranda, references, etc., endeavor to chronologically outline prediction methods used operationally in the field during Test Operations of nuclear devices fired into the atmosphere.

32743 (PB—86-152121/XAB) Maryland power plant siting program radioecology database management system: format for coding radioecology data. Final report. Domotor, S.L. (Maryland Dept. of Natural Resources, Annapolis (USA). Power Plant Siting Program). Jan 1986. 28p. NTIS, PC A03/MF A01.

The Radioecology Laboratory of the State of Maryland Power Plant Siting Program (PPSP) conducts routine radiological monitoring programs designed to assess the environmental impact of radionuclides released by nuclear power plants affecting Maryland. The PPSP radioecology database management system was initiated to store existing and future monitoring data collected by PPSP and its subcontractors in a computer file format. From these files, SAS (Statistical Analysis System) datasets are created for qualitative and quantitative analysis of monitoring data, for modeling studies through incorporation of this data, or for predicting environmental impact. The system was designed to accommodate both gamma and beta radionuclide analyses from water, sediment, soil, air, foodstuff, and aquatic and terrestrial flora and fauna sample types. Plant releases of radionuclides and physical and chemical environmental parameters can also be stored.

32744 (PB—86-158011/XAB) Design and development of an air sampler for the environmental radiation ambient monitoring system (ERAMS). Miller, B.J. (Environmental Protection Agency, Montgomery, AL (USA). Eastern Environmental Radiation Facility). Dec 1985. 16p. (EPA/520/5—85/032). NTIS, PC A02/MF A01.

The newly designed air sampler for the ERAMS network meets all the desired design characteristics. Units have been in use at some ERAMS stations for more than two years and have operated satisfactorily. No samples have been lost due to inoperative samplers. Sampling air flow rates are adequate to collect the desired sample volume. Purchase cost, operating costs, and repair costs are greatly reduced compared to the previously used samplers. The small physical size and light weight result in a unit that is inexpensive and easy to ship and to get into the operating location. Operating life of the blower is adequate to minimize the inconvenience and cost associated with frequent replacement. Ease of operator use and low operating noise result in a unit that has been readily accepted by the station operators.

32745 (RHO-HS-SR—85-2-4Q-GAS-P) Radioactivity in gaseous waste discharged from the separations facilities during 1985. Aldrich, R.C.; Stanfield, L.J. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). 25 Feb 1986. Contract AC06-77RL01030. 62p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86009994.

This document summarizes the radioactivity in gaseous wastes discharged by Rockwell Hanford Operations. (Rockwell) during CY 1985. During CY 1985, 74 stacks discharged gases which were normally contaminated or potentially contaminated with radioactive material. Emission levels were such that personnel and public exposures were well below DOE guidelines. Also, all stack emissions with the exception of the PUREX Ammonia Scrubber Discharge (296-A-24) were below Rockwell administrative controls based on the As Low As Reasonably Achievable philosophy. The PUREX Ammonia Scrubber Discharge stack (296-A-24) exceeded the Rockwell administrative control value for Ruthenium-106 by 17%.

32746 Tritium production, releases and population doses at nuclear power reactors. Peterson, H.T.; Baker, D.A. (Nuclear Regulatory Commission, Washington, DC). *Fusion Technology;* 8: No. 2, 2544-2550(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Tritium is produced in light-water-cooled reactors as a product of ternary fission and by nuclear reactions with the coolant and with neutron-absorbing materials used for reactor control. Pressurized water reactors (PWRs) have greater amounts of tritium produced in or released into the coolant than boiling water reactors (BWRs). Consequently, tritium releases to the environment from PWRs (29 GBq/MW(e)-y (0.78 Ci/MW(e)-y)[6] are about 6 1/2 times greater than from BWRs (4.4 GBq/MW(e)-y (0.12 Ci/MW(e)-y)[6]. Most of the tritium released from PWRs appears in the liquid effluent (about 85%), whereas 75% of the tritium released from BWRs is as airborne effluents. Radiation doses from these tritium releases are small; the average site collective (population) dose in 1981 was less than 0.002 person-sieverts per year (0.2 person-rem/ year). The total collective dose from all tritium releases was 0.08 personsieverts (8 person-rem).

32747 Global environmental transport models for tritium. Killough, G.G.; Kocher, D.C. (Oak Ridge National Laboratory, Oak Ridge, TN). *Fusion Technology;* 8: No. 2, 2569-2574(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

In this paper we discuss some of the obstacles to the construction of credible models of tritium transport for use in dose assessments. We illustrate these difficulties by comparing model predictions of environmental tritium levels with measurements. Environmental monitoring of tritium has shown that specific activities in precipitation over land are typically higher by a factor of three to four than those in precipitation over the oceans. Experience with modeling CO_2 turnover in the oceans has led to the conclusion that two-box reservoir models of the ocean often give unsatisfactory representations of transient solutions. Failure to consider these factors in global models can lead to distorted estimates of collective dose and create difficulties in validation of the model against real data. We illustrate these problems with a seven-box model recommended by the National Council on Radiation Protection and Measuremer.ts (NCRP), in which we forced the atmospheric compartment to reproduce an exogenous function based on historic observations of HTO in precipitation at 50°N.

32748 Radon in homes and other technologically enhanced radioactivity. Rundo, J.; Toohey, R.E. (Argonne National Lab., IL). pp 17-25 of Environmental radioactivity : proceedings of the nineteenth annual meeting. Bethesda, MD; National Council on Radiation Protection and Measurements (1983).

The sources of radon in homes are discussed, and typical values of radon concentration inside houses are presented. Available evidence suggests that the principal source of radon is soil gas, and that the type of heating system in a home (whether it circulates the air or not) has a dramatic effect on concentration. The radiation dose to tissues, especially lung, of the human body is largely due to short-lived daughter products, Polonium 218, Lead 214, Bismuth 214, and Polonium 214. A strong case is presented for the proposition that not enough data exists to adequately assess these questions. 19 references, 2 figures, 2 tables.

5004 Thermal Effluents Monitoring And Transport

REFER ALSO TO CITATION(S) 31989

32749 (SRD-R—304) Atmospheric transmissivity: the effects of atmospheric attenuation on thermal radiation. Simpson, I.C. (UKAEA Safety and Reliability Directorate, Culcheth). Oct 1984. 124p. United Kingdom Atomic Energy Authority Wigshaw Lane, Culcheth Warrington, England WA3 4NE. File Number TI86901202.

This report is a review of the work carried out on atmospheric absorption (or, conversely, atmospheric transmissivity) which falls into two main sections: A literature review on atmospheric transmissivity and the various empirical methods of predicting atmospheric transmissivity. One of these empirical methods has been investigated in detail by SRD and a small computer program developed, which uses this method to determine atmospheric attenuation, by both absorption and scattering. Using the computer program a series of graphs indicating the variation of atmospheric transmissivity with distances, with relative humidity as a parameter, for black bodies at various temperatures have been produced. The inclusion of a value for atmospheric transmissivity in the calculation of hazard ranges from pool fires and fire-balls will give, for

typical UK atmospheric conditions, a reduction in hazard range of 10 to 40%.

5005 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 32701

5006 Regulations

REFER ALSO TO CITATION(S) 32133, 32134, 32135, 32136, 32137, 32138, 32139, 32140, 32141, 32142, 32143, 32144, 32145, 32767

32750 (TVA/ONRED/AWR—86/11, pp 6-18) **Opening Session.** Nov 1985. NTIS, PC A04/MF A01. File Number DE86901133. (CONF-8510298—Absts.).

From 2. annual acid rain conference for the Southern Appalachians; Gatlinburg, TN, USA (28 Oct 1985).

Topics and leaders were: Acid rain control: legislation and implementation issues - T.L. Montgomery; Forest effects research programs in the southeastern United States - A.M. Bartuska; The integrated forest study on effects of atmospheric deposition - D.W. Johnson, S.E. Lindberg, and E.A. Bondietti; Aquatic and terrestrial research program at the EPA Corvallis Laboratory - R.T. Lackey, J.J. Messer, and R. Linthurst; and The National Stream Survey - Phase I pilot: some preliminary findings - J.J. Messer, C.W. Ariss, A. Kinney, J. Baker, W.S. Overton, M.J. Sale, and J.R. Tuschall.

51 ENVIRONMENTAL SCIENCES, TERRESTRIAL

5101 Basic Studies

32751 (CONF-8603106—1) **Some important elk-forest habitat relationships for Western Oregon and Washington.** Witmer, G.; Wisdom, M. (Argonne National Lab., IL (USA); Bureau of Land Management, Coos Bay, OR (USA)). 1986. Contract W-31-109-ENG-38. 14p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009167.

From Western states elk workshop; Coos Bay, OR, USA (17 Mar 1986).

The report identifies some basic Roosevelt elk - habitat relationships so that the needs of elk could be better integrated with forestry practices and other human activities occurring in the forestlands of western Oregon and Washington. The relationships discussed are: space and water, large areas, cover areas, and interspersion component, and the roading/disturbance component. (ACR)

32752 (DOE/ER/40048—102-L4, pp 54) **AMS with carbon and beryllium: C-14 and Be-10 radiochronology.** Balsley, D.; Farwell, G.W.; Grootes, P.M.; Hinn, G.M.; Leach, D.D.; Schmidt, F.H. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Measurements of isotopic fractions in the range of 10^{-11} to 10^{-14} for studies of the variations in ^{10}Be and ^{14}C concentrations in environmental samples have been continued during the past year, and a number of significant technical improvements have been made.

32753 **Lichens and lepidopterons.** Sigal, L.L. (Oak Ridge National Lab., TN). *Bryologist;* 87: No. 1, 66-68(1984). Contract W-7405-ENG-26.

The newly found association of Usnea strigosa (Ach.) A. Eat. and the lichenophagous larva of the moth Zanclognatha theralis (Walker) is described. The possible biological role of lichen acids in the lichen-moth relationship is discussed.

32754 **Role of soil invertebrates in turnover of organic matter and nutrients.** Edwards, C.A.; Reichle, D.E.; Crossley, D.A. Jr. pp 147-172 of Ecological studies. Analysis and synthesis, Volume 1. Reichle, D.E. (ed.). Berlin, Germany, F.R.; Springer-Verlag (1970).

The turnover of plant organic matter is discussed in general terms. The processes which cause litter breakdown are discussed, along with the breakdown of woody materials and root breakdown. Methods used in studying litter breakdown by soil animals are discussed, including studies of the animal populations themselves, loss of weight, nutrients, and energy by the litter, and the physical disappearance of litter leaf area. The effects of climatic conditions on organic matter turnover are discussed. Trophic models of the energy flow and nutrient cycles through soil populations are presented, and expressions are developed to estimate assimilation, respiration of organisms and calorific values. Net production by animals of different trophic levels is discussed and mathematically described. 157 references, 2 figures, 4 tables.

5102 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 32727, 32732, 32733, 32780, 32783, 32856

32755 (GPO—5-472) **International Geosphere/Biosphere Program, 1984.** (Committee on Science and Technology (U.S. Congress. House), Washington, DC). 1985. 41p. US Capitol, House Document Room.

The present status of the International Geosphere/Biosphere Program (IGBP) is discussed. The IGBP will contribute to the understanding of the Earth as a system, and could deal with problems such as acid rain and the CO_2 greenhouse effect. The IGBP will be an international and interdisciplinary study of the Earth as a system and the man induced and natural changes in that system. In the U.S. it will involve several Federal agencies and universities.

32756 (ORNL/M—152) **Factors affecting the long-term response of surface waters to acidic deposition: state-of-the-science.** Turner, R.S.; Johnson, D.W.; Elwood, J.N.; Van Winkle, W.; Clapp, R.B.; Jones, M.L.; Marmarek, D.R.; Thornton, K.W.; Gherinig, S.A.; Schnoor, J.L. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 271p. NTIS, PC A12/MF A01; 1; GPO Dep. File Number DE86010006.

Recent intensive study of the causes of surface water acidification has led to numerous hypothesized controlling mechanisms. Among these are the salt-effect reduction of alkalinity, the base cation buffering and sulfate adsorption capacities of soils, availability of weatherable minerals (weathering rates), depth of till, micropore flow, and type of forest cover. Correlative and predictive models have been developed to show the relationships (if any) between hypothesized controlling mechanisms and surface water acidity, and to suggest under what conditions additional surface water might become acid. This document (Part A) is a review of our current knowledge of factors and processes controlling soil and surface water acidification, as well as an assessment of the adequacy of that knowledge for making predictions of future acidification. Section 2 is a data extensive, conceptual overview of how watersheds function. Section 3 is a closer look at the theory and evidence for the key hypotheses. Section 4 is a review of existing methods of assessing system response to acidic deposition.

32757 (ORNL/TM—9953) **Assessment of risk methodologies for DOE hazardous chemical waste sites. Status report for period ending September 30, 1985.** Hively, L.M.; Barnthouse, L.W.; Kocher, D.C.; Munro, N.B.; Smith, E.D.; Travis, C.C. (Oak Ridge National Lab., TN (USA)). Mar 1986. Contract AC05-84OR21400. 34p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010085.

The purpose was to review and evaluate existing models and methodologies for their applicability to development of a risk-assessment-based scoring and ranking system for use in DOE's Hazardous Chemical Defense Waste Program (HWP). In addition to describing and evaluating existing assessment schemes, desirable criteria are identified for a risk assessment methodology tailored specifically to the needs of the HWP. The report summarizes the three basic kinds of assessment models: scoring, simulation, and statistical, and evaluates strengths and weaknesses of the various methods as they relate to the needs of the HWP.

32758 **Equisetum and the cycling of mercury at Mount St. Helens: plant-soil relations, 1980-1984.** Siegel, S.M.; Siegel, B.Z. (Univ. of Hawaii at Manoa, Honolulu). *Water, Air, and Soil Pollution;* 27: No. 3-4, 441-444(1986).

The Hg content of Equisetum shoots at six stations near Mount St. Helens rose to a peak value in July 1982, 26 mo after the great eruption of May 1981. The July 1982 peak in plant Hg content was followed by a continual decline in plant tissue Hg at all six stations as measured in September 1982 and August 1984. During this 2 yr period, soil Hg levels declined at only three of the six stations, while remaining essentially unchanged at two stations and increasing nearly 20-fold at one station. Therefore, soil Hg behaved independently with respect to plant Hg at least at three of the six sites. This follow-up study at Mount St. Helens supports the notion of a major source of atmospheric mercury which is taken up directly by plants.

5103 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 31572, 31573, 31576, 31595, 31598, 31599, 31601, 31603, 32740, 32743, 32856, 32872

32759 **(BRGM-TH—75) Migration and fixation of Uranium in the surficial environment. Case histories and applications to geochemical exploration.** Pradier, B. (Bureau de Recherches Geologiques et Minieres (BRGM), 45 - Orleans (France)). [1986]. 337p. (In French). NTIS (US Sales Only), PC A15/MF A01. File Number DE86751777.

Uranium geochemistry is studied in three different test areas: surface waters, sediments, and isohumic soils. Using data from the WATEQ-type thermodynamic model the state of uranium in sampled waters is examined. Uranium is present in the oxidized state U^6, as uranyl ion UO_2^{++}, complexed by the HPO_4^{--} ion and CO_3 ion. Estimated residual uranium values, have shown the very probable existence of a non mineral support for uranium in solution, probably uranyl-fulvates. Uranium in stream-sediments is preferentially located in the fine-grained fractions. The bearing phases of the geochemical uranium, identified in the fine-grained fractions, are mainly composed by amorphous or cryptocrystallized iron oxihydroxide, and accessorily by fulvic (and humic) acids. Ferric phases support 60 to 75% of the total uranium. In the isohumic soils, the uranium mobility depends on the existence of highly reactive and poorly evoluted organic compounds, and amorphous or cryptocristallised ferric phases located in the first centimeters of the upper horizon. The recognition of the factors governing uranium behavior in the superficial media requires the preliminary definition of the uranium expression in waters, and that of its bearing phases in soils and stream-sediments. High uranium content in waters are not significant if related to high HCO_3^- and/or PO_4^{3-} content, and doubtlessly to high dissolved organic carbon content. The interest of residual uranium mapping in stream-sediment geochemistry is underlined. Data are computed by difference between natural value and the corresponding estimated value, calculated by regression taking in account the adsorbant phases content of each sample.

32760 **(DOE/OR/20722—98) Niagara Falls Storage Site annual site environmental monitoring report. Calendar year 1985.** (Bechtel National, Inc., Oak Ridge, TN (USA). Advanced Technology Div.). Apr 1986. Contract AC05-81OR20722. 88p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86009982.

During 1985, an environmental monitoring program was continued at the Niagara Falls Storage Site (NFSS), a United States Department of Energy (DOE) surplus facility located in Niagara County, New York, presently used for the interim storage of low-level radioactive residues and contaminated soils and rubble. The monitoring program is being conducted by Bechtel National, Inc. Monitoring results show that the NFSS is in compliance with DOE concentration guides and radiation protection standards. Derived Concentration Guides (DCGs) represent the concentrations of radionuclides in air or water that would limit the radiation dose to 100 mrem/yr. The applicable limits have been revised since the 1984 environmental monitoring report was published. The limits applied in 1984 were based on a radiation protection standard of 500 mrem/yr; the limits applied for the 1985 are based on a standard of 100 mrem/yr. To determine whether the site is in compliance with DOE standards, environmental measurements are expressed as percentages of the applicable DCG, while the calculated doses to the public are expressed as percentages of the applicable radiation protection standard. The monitoring program measured radon gas concentrations in air; uranium and radium concentrations in surface water, groundwater, and sediments; and external gamma dose rates. Environmental samples collected were analyzed to determine compliance with applicable standards. Potential radiation doses to the public were also calculated.

32761 **(ORNL—5970) PRESTO-II: a low-level waste environmental transport and risk assessment code.** Fields, D.E.; Emerson, C.J.; Chester, R.O.; Little, C.A.; Hiromoto, G. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 470p. NTIS, PC A20/MF A01; 1; GPO Dep. File Number DE86010061.

PRESTO-II (Prediction of Radiation Effects from Shallow Trench Operations) is a computer code designed for the evaluation of possible health effects from shallow-land and, waste-disposal trenches. The model is intended to serve as a non-site-specific screening model for assessing radionuclide transport, ensuing exposure, and health impacts to a static local population for a 1000-year period following the end of disposal operations. Human exposure scenarios considered include normal releases (including leaching and operational spillage), human intrusion, and limited site farming or reclamation. Pathways and processes of transit from the trench to an individual or population include ground-water transport, overland flow, erosion, surface water dilution, suspension, atmospheric transport, deposition, inhalation, external exposure, and ingestion of contaminated beef, milk, crops, and water. Both population doses and individual doses, as well as doses to the intruder and farmer, may be calculated. Cumulative health effects in terms of cancer deaths are calculated for the population over the 1000-year period using a life-table approach. Data are included for three example sites: Barnwell, South Carolina; Beatty, Nevada; and West Valley, New York. A code listing and example input for each of the three sites are included in the appendices to this report.

32762 **Studies of small-mammal populations on the radioactive White Oak Lake bed.** Dunaway, P.B.; Kaye, S.V. (Oak Ridge National Lab., TN). pp 167-185 of Transactions of the twenty-sixth North American wildlife and natural resources conference, March 6, 7, and 8, 1961. Washington, DC; Wildlife Management Institute (1961).

Populations of small mammals were studied on the radioactive White Oak Lake bed after the lake was drained. Small-mammal populations were also studied on an uncontaminated old field. The cotton rat was the dominant small-mammal species on the lake-bed area from the summer of 1957 to the winter of 1959-1960. The populations of cotton rats were exterminated on the lake-bed and old-field areas during the severe winter of 1959-1960. Greatest trapping success at the lake bed was in the summers. The number of animals caught on the lake bed in spring was only slightly less than in fall because of immigration during winter and early spring. About 35 per cent of the 248 rats were apparently transients. Significantly more males than females were caught at the lake bed (178 males to 137 females; $chi^2 = 5.336$, $P = 0.025$). More females than males were trapped from late spring or summer to late fall or early winter, while more males were captured during the remaining time. The reproductive season occurred mainly from about April to October. Strontium-90 was the most abundant radioisotope in the tissues and was the only radioisotope present in greater concentrations in the tissues (625 $\mu\mu$c/g, dry wt.) than in the food (132 $\mu\mu$/g, dry wt.). Effects of atomic radiation were not detected in this study.

5104 Thermal Effluents Monitoring And Transport

REFER ALSO TO CITATION(S) 32039

5105 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 31603, 31982, 32867

32763 (ANL—86-13) 1985 annual site environmental report for Argonne National Laboratory. Golchert, N.W.; Duffy, T.L.; Sedlet, J. (Argonne National Lab., IL (USA)). Mar 1986. Contract W-31-109-ENG-38. 103p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86009453.

This is one in a series of annual reports prepared to provide DOE, environmental agencies, and the public with information on the level of radioactive and chemical pollutants in the environment and on the amounts of such substances, if any, added to the environment as a result of Argonne operations. Included in this report are the results of measurements obtained in 1985 for a number of radionuclides in air, surface water, ground water, soil, grass, bottom sediment, and milk; for a variety of chemical constituents in surface and subsurface water; and for the external penetrating radiation dose.

32764 (ORNL—6026/V6/A1) Resource Management Plan for the US Department of Energy Oak Ridge Reservation. Volume 6. Forest management. Addendum 1. Cost/benefit review. Bradburn, D.M.; Loar, J.M.; Petrich, C.H.; Jones, C.G.; Parr, P.D.; Voorhees, L.D. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)). Mar 1986. Contract AC05-84OR21400. 57p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010087.

This review weighs the benefits of forest management (FM) activities on the Department of Energy (DOE) Oak Ridge Reservation (ORR) against the costs of those activities. The review's objectives are (1) to determine whether the FM program is cost beneficial and (2) to discover means of improving the cost effectiveness. By improving the cost effectiveness of the FM activities, the entire program can be strengthened and existing resources can be used even more effectively. Benefits may be either tangible or intangible, direct or indirect. No direct tangible benefits are credited to the FM program. Indirect tangible benefits are derived from the sale of merchantible timber, pulpwood, firewood, and hay. However, these revenues go directly to the US Treasury and thus do not offset any program costs. The other benefits are intangible. These are, in the most general terms, fire protection, disease control, research assistance, aesthetic improvements, improvements to certain wildfire habitats, reforestation, timber stand improvement, increased opportunities for research, and timber salvage. Costs for the FM program include capital and operating expenses. The annual operating budget, which is currently around $200,000, covers personnel salaries and materials but not capital equipment purchases. In general terms, the intangible costs include, but are not limited to, disturbance of soil, reduction of undisturbed areas for research, impacts on watersheds, aesthetic changes, and changes in wildlife habitats.

32765 (SREL—21) Bald and Golden Eagles of the SRP. [Annual report, 1986]. Mayer, J.J.; Hoppe, R.T.; Kennamer, R.A. (Savannah River Ecology Lab., Aiken, SC (USA)). 1986. Contract AC09-76SR00819. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009972.

Both Bald and Golden Eagles have a prior history of occurrence on the Savannah River Plant (SRP). Sightings of Bald Eagles have been uncommon but persistent, while Golden Eagle sightings have been rare. A one-year survey was conducted to assess the use of the SRP by these two species. Thirty-six Bald Eagles were seen during the study period. No Golden Eagles were observed. Over 90% of the Bald Eagle sightings were on Par Pond; three out of four of these birds were adults. Thirteen percent of the sightings were of paired birds, and the remainder were of solitary individuals. Bald Eagles were observed during every month of the survey. The majority were seen between November and May. Sightings were evenly divided between morning and afternoon hours. Two marked Bald Eagles were observed. Since the conclusion of this study, twenty-two Bald Eagles have been reported. Six were new locality records for the SRP. Four of these sightings were on L-Lake. Bald Eagle use of the SRP is higher than was previously thought; Golden Eagle use remains rare.

32766 (UCRL—15794) Magnitude and spatial distribution of urban flammable materials in the San Jose Area, California. Simonett, D.S.; Barrett, T.N.; Gopal, S.; Holsmuller, F.J.; G.Q. Sun. (California Univ., Santa Barbara (USA). Dept. of Geography). Feb 1986. Contract W-7405-ENG-48. 81p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86009696.

The distribution and quantity of flammable materials in urban areas is of importance for any study of the fire spread and plume dynamics which may result from a nuclear attack. This study presents a methodology which uses aerial photographs and a 1000 feet sample grid to collect this information for San Jose and adjoining urban areas in California. A detailed literature search was carried out to develop estimates of the fuel loading of the major building types in an urban environment. Due to the ambiguities in this literature, the values as used here are approximations, but are supported by details of sources and assumptions. Some straightforward calculations using the results from the air photo interpretation and the literature search, yield information about the fire load and also urban characteristics per grid cell, including information on fire breaks which are important features with respect to fire spread. The results yield an average preliminary and partial fuel value of 9.2 kg/m^2. This value is less than fuel loads estimated in the literature using different methods of obtaining data and is certainly less than the actual fuel loading for San Jose. However, we doubt that with further work we will find the average San Jose value to be any higher than 13 kg/m^2. Additional sources of fuel which remain to be accounted for both in aggregate magnitude, and expected burnable fractions, include asphalt of roofs, streets, sidewalks, and parking lots, fuel storage facilities, fuel and natural gas in pipelines, natural vegetation, and external storage of lumber, construction, commercial and industrial-process materials.

5106 Regulations

REFER ALSO TO CITATION(S) 31974, 31983, 32791

32767 (ORNL/M—153) Science advisory board review of the Forest Effects Research Program. Barnard, J.E.; Bartuska, A.M.; Bradow, R.L.; Cowling, E.B.; Fege, A.; Hood, B.; Janetos, A.; Joyner, K.; Marx, D.H.; Pagano, T.A. (Oak Ridge National Lab., TN (USA)). 6 Jun 1985. Contract AC05-84OR21400. 213p. NTIS, PC A10/MF A01; 1; GPO Dep. File Number DE86010005.

The Science Advisory Board review document of the Forest Effects Research Program lays out the rationale, scope, and approach for implementing a joint research program sponsored by the US Environmental Protection Agency and the US Forest Service to investigate the impacts of air pollutants in US forests. The overall goals of the research program are: (1) to determine to what degree air pollutants may be stressing US forests; (2) if that stress is severe, to develop dose-reponse relationships and target loadings for the important pollutants; and (3) to develop and implement a program in US forests that will monitor their exposure and response to air pollutants over the long term. The research program was initiated by the EPA, the Forest Service and the university research community in the summer of 1984. The program will be sponsored by Task Group F, the Terrestrail Effects branch of the National Acid Precipitation Assessment Program (NAPAP). Task Group F is chaired by the Forest Service; the EPA is an important memember along with other organizations including the Department of Energy, the Cooperative States Research Service, the National Park Service and the US Geological Survey.

52 ENVIRONMENTAL SCIENCES, AQUATIC

5201 Basic Studies

REFER ALSO TO CITATION(S) 32870

32768 **(BNL—37972) Zooplankton data report: the Marginal Ice Zone Experiment MIZEX, 1984.** Smith, S.L.; Lane, P.V.Z.; Schwarting, E.M. (Brookhaven National Lab., Upton, NY (USA)). Mar 1986. Contract AC02-76CH00016. 242p. NTIS, PC A11/MF A01; 1; GPO Dep. File Number DE86009943.

The Marginal Ice Zone Experiment (MIZEX 84) concentrated on atmospheric, oceanic, and ice interactions in the Fram Strait region of the Greenland Sea, specifically the effect of the retreating ice margin on the productivity in the area and the use of zooplanktonic species as indicators of Arctic and North Atlantic water masses. The data in this report are the quantitative analyses of zooplankton collected while aboard the research vessel Polarstern.

32769 **(DOE/EV/10004—T3) Elements of a nitrogen budget for a stream collector. Appendix IX.** (Oregon State Univ., Corvallis (USA). Dept. of Fisheries and Wildlife). 1979. Contract AT06-79EV10004. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010382.

A simple diagram of a preliminary nitrogen budget for a generalized collector-gatherer is presented. The internal anatomy of chironomus sp. indicates its potential for fairly complex physiological processes. 26 refs., 2 figs.

32770 **(DOE/EV/10004—T4) Partitioning of macroinvertebrates in leaf packs by functional group. Appendix XI.** (Oregon State Univ., Corvallis (USA). Dept. of Fisheries and Wildlife). 1979. Contract AT06-79EV10004. 13p. NTIS, PC A02. File Number DE86010384.

Hickory leaf littler packs were studied at six sites in the Augusta Creek watershed over five sampling dates (Fall-spring). The first six tables present biomass analyses, the last six give numerical data. Only those animals retained on a 0.5 mm mesh sieve are treated; this includes all shredders, but the earliest stages of some collectors, scrapers and predators were not retained. 12 tabs.

32771 **(DOE/EV/10004—T5) Experiment on field introductions of a stream leaf shredder (Clistoronia magnifica; Insecta; Trichoptera).** Hanson, B.J.; Cummins, K.M. (Oregon State Univ., Corvallis (USA). Dept. of Fisheries and Wildlife). 1979. Contract AT06-79EV10004. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010379.

Stream macroinvertebrate growth rates have been used in laboratory experiments as bioassays to evaluate both food quality and the effects of temperature. Because laboratory conditions may not adequately represent the natural stream conditions of the test species and to evaluate the feasibility of large scale introductions of non-perpetuating introductions in the field, pilot studies using the leaf shredder Clistoronia magnifica were initiated. regulation of shredder growth rates probably results from a combination of the effects of temperature, food quality and competitive interactions. The relative importance of, and interactions between, these controls need to be tested in an array of streams which vary in temperature, food quality and potentially competing shredders. the experimental procedure involved with the introduction of late instars of a lentic leaf litter shredding caddisfly into a second order intermittent stream. 5 refs., 1 fig. 2 tabs.

32772 **(DOE/EV/10004—T6) Influence of food quality on the growth of collector stream mayflies. Appendix VII.** (Oregon State Univ., Corvallis (USA). Dept. of Fisheries and Wildlife). 1979. Contract AT06-79EV10004. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010380.

As part of the continuing collector feeding studies, questions of particular interest are selection for food quality vs. particle size, e.g., by % organic or nitrogen content, microbial biomass and/or activity. Gathering collector (FPOM-feeding) mayflies belonging to large, widely distributed genera were chosen for study: Ameletus sp. (Siphlonuridae) and Ephemerella delantala and E. infrequens (Ephererellidae). 4 tabs.

32773 **(GKSS—85/E/56) Three-dimensional tidal flat system.** Pfeiffer, K.D. (GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.); Hamburg Univ. (Germany, F.R.). Fachbereich Geowissenschaften; GKSS-Forschungszentrum Geesthacht G.m.b.H., Geesthacht-Tesperhude (Germany, F.R.). Inst. fuer Physik). 1985. 112p. (In German). NTIS (US Sales Only), PC A06/MF A01. File Number DE86752026.

A three-dimensional barotropic and vertically high resolving numerical model for shallow water and tidal flats areas was developed. The model was adapted to channels and basins of various topographies and configurations and driven by wind stress and water level elevation at open boundaries. The formalism allows vertical discretizations according to physical considerations and necessities also in the range of the variability of the water level elevation. The model will be useful especially involving estuarine and nearshore problems with marked nonlinearities in the flow field and high vertical gradients of physical quantities. The adaptation to natural areas has been proved by modelling a section of the river Elbe in the brackish water zone. (orig.). With 53 figs.

32774 **Submerged aquatic vegetation of the Chesapeake Bay: past, present and future.** Orth, R.J.; Moore, K.A. (College of William and Mary, Williamsburg, VA). pp 271-283 of Transactions of the 46th North American wildlife and natural resources conference, 1981. Washington, DC; Wildlife Management Institute (1981). Contract AC02-76CH00016.

The entire shoreline of the Chesapeake Bay and its tributaries were flown with light planes equipped with mapping cameras during 1979. The imagery of the grass beds was then mapped onto standard USGS topographic quadrangles and the areas of the grass beds was calculated with an electronic planimeter. Data for the past distribution and abundance of SAV (submerged aquatic vegetation) in the Bay were acquired from historical aerial photographs dating back to 1937 by SUGS and USDA, and from numerous field surveys conducted by the Maryland DNR and individual scientists throughout the Bay area. Results of the survey indicate that the Bay still contains significant stands of vegetation. At present, the vegetation seems to be undergoing a generalized decline in extent, but it has not yet been determined whether this decline is outside the range of normally-occurring fluctuations. A position of guarded optimism is taken regarding the future. 16 references, 3 figures.

5202 Chemicals Monitoring And Transport

REFER ALSO TO CITATION(S) 31321, 31322, 31587, 31987, 32733, 32756, 32856

32775 **(AD-A—164161/2/XAB) Survey of copper in Kings Bay and Cumberland Sound. Final report, 15-23 January 1985.** Lieberman, S.H.; Johnston, R.K.; Bower, D.R.; Inman, S.M. (Naval Ocean Systems Center, San Diego, CA (USA)). Oct 1985. 110p. (NOSC/TR—1062). NTIS, PC A06/MF A01.

A multiparameter survey consisting of physical, chemical, and biological measurements was performed to map the copper distribution in Kings Bay and Cumberland Sound, Georgia. The results of this study suggest (1) Kings Bay was probably not a source of elevated copper levels during the study interval, (2) dewatering of the dredge spoil containment area does not appear to be a souce of cooper pollution, and (3) concentrations in the Lower Turning Basin of Kings Bay were slightly higher than levels in the Upper Basin or in Cumberland Sound, suggesting possible input from copper antifouling coatings.

32776 **(DOE/ER—0262) Anoxic collection and analysis of subsurface water samples.** Dodge, C.J.; Francis, A.J. (Brookhaven National Lab., Upton, NY (USA)). Feb 1986. Contract AC02-76CH00016. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86008700.

A sampling scheme was developed which maintains the anoxic nature of the well water at or near in situ conditions after collection and allows the sample to be stored in the refrigerator for many months without appreciable chemical changes. A unique feature of this system is that the sample does not come in contact with atmospheric oxygen during collection. All sample lines, probe holders, and bottles are preflushed with nitrogen gas before sampling and the addition of air barrier coils prevents the entry of air back into the sample bottles.

32777 **(ENEA-RT/FARE-SIN—81-2) Use of macro and microphytes for water pollution control: a practical demonstration.** Marzetti, P.; Pacciaroni, F.; Severi, A. (ENEA, Casaccia (Italy). Dipartimento Fonti Alternative Rinnovabili e Risparmio Energetico; Ufficio Tecnico del Comune di Bastia Umbra, PG (Italy)). Dec 1981. 25p. (In Italian). (CONF-8105272—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86900989.

From Congress on hypotheses of a fluvial oasis on the Chiascio River; Bastia Umbra, Italy (29 May 1981).

Different biological systems, most frequently used in water pollution control, are reviewed. Photosynthetic bacteria and microalgae have been considered both for their theoretical potentiality and the possibility of practical applications. Among the macrophytes, aquatic rooted plants (Scirpus lacustris, Thypha latifolia, etc.) and floating plants (Lemma minor, Eichhornia crassipes, etc.) have been described for their wide utilization in wastewater treatment experiments. Information on the sewage treatment plant, located at Bastia Umbra (PG) using a controlled water-hyacinth culture is reported. The plant consists of four cell lagoons with a total surface area of about 1500 square meters. The system has been designed to handle the waste of approximately 1000 people, plus some industrial wastes. The results obtained in two years of experiments appear to be promising for the development of bio-filtration wastewater systems.

32778 **(FWS/OBS—80/40.18) Effects of acidic precipitation on Atlantic salmon rivers in New England.** Haines, T.A.; Akielaszek, J.J. (Fish and Wildlife Service, Orono, ME (USA). Columbia National Fisheries Research Lab.). Oct 1984. 123p. NTIS, PC A06/MF A01. File Number TI86901100.

Air Pollution and Acid Rain Report 18.

This study was conducted to determine whether some of the Atlantic salmon resources in New England are at risk from acidification as a consequence of acidic precipitation. We selected nine Atlantic salmon streams for an intensive water chemistry survey. Eight of these were in Maine and presently support major naturally reproducing populations of Atlantic salmon; one was in Vermont and is receiving hatchery introductions. An effort was made to locate previous water chemistry data that could be compared to the present data.

32779 **(INIS-mf—9879) Numerical tables. Physical and chemical analyses of Rhine water 1984.** (Internationale Kommission zum Schutze des Rheins gegen Verunreinigung, Koblenz (Germany, F.R.)). 1984. 115p. (In German, French and Dutch). NTIS (US Sales Only), PC A06/MF A01. File Number DE86751747.

Tables present the methods of analysis and the data obtained on inorganic, organic, and radioactive impurities in Rhine water. The measuring stations were located in Switzerland, France, West Germany, and the Netherlands. (HP).

32780 (INIS-mf—9886, pp 17-19) **Dioxin - which method of analysis to choose.** Ploeger, E. Jan 1985. (In German). NTIS (US Sales Only), PC A04/MF A01. File Number DE86752052.

In State Authority for Water and Waste Management of North-Rhine Westphalia. Annual report '84.

Dioxin - one of the super-poisons of the 20th century, especially the 2,3,7,8-TCDD is expected to be found in solid waste and waste water. It is therefore important to determine even small traces of dioxin in these media as precisely as possible. Analysis itself is difficult enough but the crucial point is preparation of samples. It is necessary to separate dioxenes as completely as possible from other material and to enrich it. This needs great experience and most diligent work. Error factors of one thousand are not uncommon. (orig./PW).

32781 **(ORNL/TM—9787) Factors affecting response of surface waters to acidic deposition.** Turner, R.S.; Johnson, D.W.; Elwood, J.W.; Van Winkle, W.; Clapp, R.B.; Reuss, J.O. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 152p. NTIS, PC A08/MF A01; GPO Dep. File Number DE86010067.

Environmental Sciences Division Publication No. 2596.

Knowledge of watershed hydrology and of the biogeochemical reactions and elemental pools and fluxes occurring in watersheds can be used to classify the response of watersheds and surface waters to acidic deposition. A conceptual mosel is presented for classifying watersheds into those for which (1) surface water chemistry will change rapidly with deposition quality (direct response) (2) surface water chemistry will change only slowly over time (delayed response), and (3) surface water chemistry will not change significantly, even with continued acidic deposition (capacity-protected). Techniques and data available for classification of all watersheds in a region into these categories are discussed.

32782 **(PB—86-154424/XAB) Managing vegetation on peat-sand filter beds for wastewater disposal. Forest Service research note.** Elling, A.E. (Forest Service, St. Paul, MN (USA). North Central Forest Experiment Station). 1985. 5p. (FSRN-NC—333). NTIS, PC A02/MF A01.

Five species of grass, one sedge, and cattail were grown on a peat-sand filter bed irrigated with sewage effluent. Yields, uptake of nitrogen and phosphorus, and lodging problems were determined for all species when grown to various heights ranging from 5 to 75 cm.

32783 **(PB—86-156239/XAB) Chemical composition of precipitation and watershed samples collected at Deep Creek Lake, Garrett County, Maryland. Final report.** Campbell, S. (Martin Marietta Environmental Systems, Columbia, MD (USA)). Oct 1985. 93p. NTIS, PC A05/MF A01.

The objective of the four-year study was to determine if acid deposition and acid stream drainage pose a significant threat to Deep Creek Lake, Maryland. The chemical composition of rain in the fourth year did not vary significantly from previous years. The annual volume-weighted mean pH of rain at the site is 3.9 - 4.0. Concentrations of hydrogen and sulfate ions are higher in summer rain, particularly for storms characterized by northwesterly winds. Summertime rain produces about 60 percent of the annual sulfate and hydrogen ion deposition at the site. The average lake water pH has remained stable during the four-year study. Acid input from Cherry Creek, impacted by geological acids, was about equal to the acid deposited directly on the lake surface by rain. During most of the year neutralization of geologic acid drainage by the bottom sediments of Cherry Creek Cove is rapid. A USGS investigation of the geology in the area found extensive alkaline rock outcroppings in the basin and underlaying the lake. It appears that concerns about rapid acidification of the lake are not well founded.

32784 **(PB—86-156734/XAB) Water resource baseline data and assessment of impacts from acidic precipitation, Acadia National Park, Maine. Technical report (Final).** Kahl, J.S.; Andersen, J.L.; Norton, S.A. (Maine Univ., Orono (USA). Dept. of Geological Sciences). Jun 1985. 134p. (TR—16). NTIS, PC A07/MF A01.

The chemistries of 18 lakes and 23 streams were studied at Acadia National Park, Maine during 1982-84. ANP is located on granitic bedrock, with thin to non-existent soils and steep topography, resulting in poorly buffered, oligotrophic surface waters. Mean baseflow pH was 5.93, 6.48 and 6.39 for the first-order brooks, second-order streams, and lakes, respectively. Alkalinities were 56, 140, and 61 micro eq/1. During high flow events, pH and alkalinity were depressed, partly due to titration by strong acids; dilution was estimated to account for 24 to 60% of the alkalinity declines. At least twice, HCI unrelated to atmospheric deposition was responsible for depressing alkalinities. The HCI was apparently generated from an NaCI salt-effect in soils. However, metal stratigraphy of

cores from 3 lakes indicates that air pollution and presumably acidic deposition, began more than 100 years ago.

32785 **(PB—86-168358/XAB) Protection of public water supplies from ground-water contamination. Seminar publication.** Graham, L.L.; Heath, R.C.; Hinkle, L.; Love, O.T.; McNabb, J.F. (Dynamac Corp., Rockville, MD (USA)). Sep 1985. 185p. NTIS, PC A09/MF A01.

The publication contains material from technology transfer seminars presented for the water-supply community. The document provides utility managers and operators, regulators and technical specialists with guidance for preventing contamination and alternatives for treating public ground-water supplies that are contaminated. An understanding of the processes that affect the movement and degradation of contaminants in the subsurface is essential for effective ground-water quality management. Knowledge can be gained from chapters on Ground-Water Hydrology, Classification of Ground-Water Regions and Ground-Water--Surface Water Relationship.

32786 (TVA/ONRED/AWR—86/11, pp 37-48) **Concurrent Session II: Aquatic Effects.** Nov 1985. NTIS, PC A04/MF A01. File Number DE86901133. (CONF-8510298—Absts.).

From 2. annual acid rain conference for the Southern Appalachians; Gatlinburg, TN, USA (28 Oct 1985).

Speakers and topics were: Benthic macroinvertebrate assemblages in acid-sensitive streams in the Southern Appalachians - P.J. Lasier, P.V. Winger, and M.J. VanDenAvyle; Response of smallmouth bass to pH dependent water quality perturbations - R.C. Young; Overview of TVA acid rain aquatic effects research - H. Olem; Linking laboratory and field responses of fish populations to acidification - W. Van Winkle, S.W. Christensen, and J.E. Breck; Use of biological indicators for detecting sublethal acidification stress in fish populations: advantages and limitations - S.M. Adams; Spatial and temporal patterns in stream chemistry in an acidic stream in the Great Smoky Mountains National Park - R.R. Turner, M.A. Bogel, J.W. Elwood, P.J. Mulholland, A.V. Palumbo, and D.M. Genung; Biological responses to different levels of stream acidification in the Southern Appalachians - P.J. Mulholland, J.W. Elwood, A.V. Palumbo, R.R. Turner, M.A. Bogle, D.R. Genung, L.A. Ferren, and A.D. Rosemond; Acid mitigation study on Laurel Branch - T.P. Weaver, E. Morgan, J.B. Moore, and H. Olem; and Methods of liming sport fish ponds - C.E. Boyd.

5203 Radioactive Materials Monitoring And Transport

REFER ALSO TO CITATION(S) 31567, 31570, 31585, 31586, 31590, 31591, 31592, 31593, 31594, 31596, 31597, 31601, 32298, 32301, 32320, 32740, 32743, 32759, 32779, 32891

32787 **(ORNL/TM—9667) Scouting treatability studies performed in support of the nonradiological wastewater treatment facility feasibility study.** Walker, J.F.; Brown, C.H. Jr. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 40p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010086.

A developmental program was undertaken to partially investigate the flowsheet being considered for the treatment of nonradiological wastewater produced by the Oak Ridge National Laboratory. The proposed flowsheet contains the following unit operations: equalization, carbon adsorption, ozonation, biodenitrification, biooxidation, filtration, reverse osmosis, and ion exchange. This report details an initial scouting program in which granular activated carbon (GAC) adsorption and reverse osmosis (RO) were operated on two of the waste streams that will be treated in the nonradiological waste treatment (NRWT) facility (190 pond influent and Building 3544 effluent). The GAC system was operated on both the 190 pond influent and the 3544 effluent, using Filtrasorb-300 activated carbon. Mercury removal was measured to be greater than 94% at an inlet concentration of 0.02 to 0.04 mg/L of mercury. Total organic carbon (TOC) removal was 40 to 70%, with inlet values of 4.6 to 5.3 mg/L of TOC. The removal of TDS, nitrate, sulfate, and mercury from the 3544 effluent was examined by RO with a cellulose acetate membrane (Osmonics) and a thin film composite membrane (FilmTec). The Osmonics membrane was operated in the feed recovery range of 64 to 95%. The corresponding rejection values were: 66 to 22.5% for nitrate, 74 to 45% for TDS, and 92 to 85% for sulfate. Mercury was not rejected at any recovery. The FilmTec membrane was operated at between 60 and 94% recovery. The corresponding rejection values were: 95.5 to 68.4% for nitrate, 95.4 to 84.5% for TDS, and 54.9 to 33% for mercury. Sulfate rejection was greater than 98.5% in all cases. Both membranes rejected more mercury upon the addition of sulfide to the feed stream, probably due to the formation of colloidal mercury sulfide. Both membranes were found to concentrate radioactive species. 12 figs., 10 tabs.

5205 Site Resource And Use Studies

REFER ALSO TO CITATION(S) 31664, 31764, 31832, 31833, 31834, 32778

32788 **(TVA/ONR/WR—83/10) Improving reservoir releases.** (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). Jun 1983. 80p. NTIS, PC A05/MF A01. File Number DE86901272.

This is the second annual report on TVA's 3-year experimental program to identify and evaluate promising techniques to enhance reservoir releases.

32789 **(TVA/ONRED/WRF—84/8) Factors affecting development of a summer, cyanophyta-dominated phytoplankton community in a mainstem Tennessee River reservoir.** Wade, D.C. (Tennessee Valley Authority, Knoxville (USA). Div. of Air and Water Resources). 16 Jul 1984. 138p. NTIS, PC A07/MF A01. File Number DE86901273.

Phytoplankton dynamics and related environmental factors were studied for thirty-two consecutive weeks to describe development of a Cyanophyta-dominated phytoplankton community in a mainstem Tennessee River reservoir. Interaction of several factors elicited strong phytoplankton response during the study and appeared as major events. These factors included rate of temperature change, solar radiation, rainfall, reservoir flow, retention time, net discharge, turbidity, nutrient concentrations, nitrogen/phosphorus ratios, and zooplankton abundance. Other factors were important over the entire study, correlating strongly with abundance of various algal taxa. These factors included net discharge, temperature, solar radiation, orthophosphate, total phosphorus, nitrite plus nitrate nitrogen, nitrogen/phosphorus ratios, copepod abundance, and water replacement. Cyanophyta population dynamics were more influenced by specific combinations of environmental events than by long-term relationships with onw or more environmental factors.

5206 Regulations

32790 **(GAO/NSIAD—86-28BR) Hazardous waste. Status of Air Force's Installation Restoration Program.** (General Accounting Office, Washington, DC (USA). National Security and International Affairs Div.). Dec 1985. 32p. General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877. File Number TI86901162.

Briefing report to Representative Vic Fazio, House of Representatives.

Ground water problems at McClellan Air Force Base were investigated in light of the remedial action program. Recommendations are given. (PSB)

32791 **(PB—86-158656/XAB) Wetlands research plan, November 1985. Published report.** Zedler, J.B.; Kentula, M.E. (Northrop Services, Inc., Corvallis, OR (USA)). Feb 1986. 125p. NTIS, PC A06/MF A01.

The plan describes the research necessary to assist the EPA in carrying out its responsibilities relative to wetlands, including Section 404 of the Clean Water Act. There are both operational and policy implications to the proposed research. Many of the products will aid 404 personnel in evaluating permit applications. Some will aid EPA in determining the relative importance of wetlands in altering water quality and, thus, help set policy determining the scope of wetlands protection.

53 Social And Economic Studies

REFER ALSO TO CITATION(S) 31977, 32086

5302 Assessment Of Energy Technologies

REFER ALSO TO CITATION(S) 31603, 31977, 32763

55 BIOMEDICAL SCIENCES, BASIC STUDIES

32792 **Reports of the University of Electro-Communications, volume 36, no. 1, September 1985 (serial no. 58).** *Denki Tsushin Daigaku Gakuho;* 36: No. 1, vp(Sep 1985).

The reports of the University of Electro-Communications are divided into two sections: (1) Science and Technology and (2) Humanity and Social Science. Some articles from the first section are entitled: (1) lamp annealing of ion implanted GaAs; (2) two level quantization of grey level picture signals; (3) computer controlled preparation of several metal complexes; and (4) carbon dioxide in the atmosphere. Some titles from the second section are: (1) arabic science - Architecture and art; (2) the use of (E)th and (E)s in verb endings; and (3) notes on Johnson's Preface to Shakespeare. Selected portions were abstracted separately.

5501 Behavioral Biology

32793 **Re: Brain blood-flow measurement with bolus intravenous $H_2{}^{15}O$.** Lambrecht, R.M.; Rescigno, A. (Brookhaven National Lab., Upton, NY). *Journal of Nuclear Medicine;* 25: No. 6, 729-730(Jun 1984).

Recently Raichle and colleagues described an implementation of the PET/autoradiographic technique for the measurement of regional cerebral blood flow with intravenously administered oxygen-15-labeled water. They successfully modified the operational equation of the one compartment arising from the Kety-Schmidt method to compensate for the fact that current PET instruments cannot measure the instantaneous tissue count rate. PET images typically require the summing of decay events for the order of 5-180 seconds. Raichle et al. critically outlined several potential sources of error in the adaptation of tissue autoradiography to PET. Although their model has limitations, which they noted, it does offer a convenient and validated method for determining regional cerebral blood flow with a diffusible tracer. We agree with the authors that an appreciation of the validity of assumptions in the kinetic models and their accuracy will lead to more precise quantification of regional cerebral blood flow with positron emission tomography. We are therefore taking exception to the generality of the assertion that the duration of a PET study to determine CBF must be constrained such that the length of data collection must not exceed 1 min for accurate, quantitative results. We suggest that their caveat is specific to the model and the method of approximation of the instantaneous tissue concentration following bolus injection of tracer.

5502 Biochemistry

REFER ALSO TO CITATION(S) 32827, 33097

32794 **(DOE/ER/10715—1) Primary gene products as plant defenses. Final report, November 1, 1983-October 31, 1984.** Murdock, L.L. (Purdue Univ., Lafayette, IN (USA). Dept. of Entomology). Apr 1986. Contract AC02-80ER10715. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010327.

Using the bruchid beetle, Callosobruchus maculatus, as a model insect we sought to understand the effects of proteinaceous inhibitors of insect digestive proteinases on growth and development of a representative pest species. We found that C. maculatus has a major migut proteinase of the thiol type which is powerfully inhibited by E-64. We devised a technique for preparing and incorporating proteinases inhibitors into artificial cowpeas: E-64, at concentrations as low as 0.01% (w/w), slowed development, increased mortality, and reduced fecundity. Clearly, thiol proteinase inhibitors in the diet of C. maculatus have a severe impact on this insect and could prevent economic infestations from developing were such inhibitors present in their natural food, i.e., cowpeas.

32795 **(DOE/ER/13106—1) Genetic approach to secretion and hyperproduction of cellulases by Trichoderma. Progress report, August 1985-April 1986.** Montenecourt, B.S.; Sands, J.A. (Lehigh Univ., Bethlehem, PA (USA)). 1986. Contract AC02-83ER13106. 10p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007858.

The multienzyme cellulase complex of the mesophilic fungus Trichoderma reesei has been studied. Our laboratory has focused on the production of high yielding mutants and the analysis of these mutants with respect to the events involved in secretion of the enzymes. The effect of glycosylation inhibitors, tunicamycin and 2-deoxyglucose and membrane perturbing agents (ethanol and phenylethanol) have been studied at both the biochemical and morphological levels. Antibodies conjugated to gold-protein A particles have localized cellobiohydrolase in the endoplasmic reticulum, Golgi and secretory vesicle regions, confirming that this general pathway, which has been firmly identified in yeast and mammalian cells, also exists in Trichoderma. Temperature sensitive secretion mutants have been isolated and one mutant, LU-ts 1, was shown to be ts for cellulase and not for protease, amylase and xylanase. At the non-permissive temperature heterogeneous protein bands are exhibited by this mutant which are inactive. This characteristic of ts for secretion is reversible. At the permissive temperature normal cellulase enzymes are secreted. 2 refs.

32796 **(DOE/ER/13278—2) Metal-binding proteins for strategic metal recovery and metal detoxification.** Leib, T.K.; Su, T.M.; Holmes, D.S. (General Electric Co., Schenectady, NY (USA). Research and Development Center). 1986. Contract FG02-84ER13278. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010776.

Some naturally occurring proteins bind metals with remarkable specificity and affinity. These properties could be useful for recovering valuable metals from dilute solution or for removal of toxic metals from waste-water. We discuss the chemical syntheses and properties of several model peptides which are based on the sequence of metal-binding protein metallothionein. Also, we describe novel techniques for determining the metal-binding properties of these synthetic peptides. These techniques are also applicable to the evaluation of naturally occurring metal-binding proteins. 16 refs., 5 figs.

32797 **(DOE/ER/13376—1) One carbon metabolism in anaerobic bacteria. Organic acid and methane production. Progress report, June 1985-May 1986.** Zeikus, J.G. (Michigan State Univ., East Lansing (USA). Dept. of Biochemistry). May 1986. Contract FG02-85ER13376. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010584.

Our project focussed on understanding of one and multicarbon metabolism in acetogenic and methanogenic bacteria. The studies with acetate catabolism pathway in Methanosarcina barkeri showed involvement of methyl reductase, methyl coenzyme M and carbon monoxide dehydrogenase in the proposed model of acetate catabolism. We also examined the relationship between hydrogen metabolism and methanogenesis, isotopic discrimination during methanogenesis, and sulfate dependent interspecies H_2-transfer between M. barkeri and Desulfovibrio vulgaris. Ammonia assimilation in Methanobacterium ivanovii via glutamine synthetase (GS) was confirmed by isolation of GS-deficient and GS-impared auxotrophic mutants. GS from M. ivanovii is also purified, characterized and compared with the eubacterial GS. In Butyribacterium methylotrophicum various enzymes involved in homoacetogenic catabolism of formate, formate plus CO and methanol plus CO were examined. Carbon dioxide was shown to be a required intermediate during catabolism of CO by B. methylotrophicum. Studies were also conducted for the operation of electron transport phosphorylation (ETP) in B. methylotrophicum by analyzing the proton motive force (PMF) and membrane bound electron carriers. 13 refs.

32798 **(DOE/ER/60069—T1) DNA damage in human cells. Final technical report, August 1982-August 1985.** Loeb, L.A. (Washington Univ., Seattle (USA). Dept. of Pathology). 1985. Contract AT06-82ER60069. 12p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010599.

The major accomplishment funded by this proposal have been the studies on apurinic sites as a common intermediate in spontaneous mutagenesis as well as mutagenesis by chemical agents. Depurination of DNA results from the cleavage of the glycosylic bond connecting the purine base to the deoxyribose sugar leaving an apurinic site. Depurination of DNA occurs spontaneously at an estimated frequency of about 10,000 events per mammalian cell per day. Moreover, depurination results from damage to DNA by a variety of processes. These include: enzymatic removal of damaged bases in DNA by specific glycosylases, chemical modifications of purine bases in order to labelize the glycosylic bond, repair of x-ray damage to DNA, and metal-drug interactions with DNA. We have accumulated evidence that depurination of DNA results in enhanced misincorporation when that DNA is copied by purified DNA polymerases in vitro. Moreover, apurinic sites in DNA cause mutations in vivo in SOS induced bacteria. Mutagenesis via apurinic sites is specific and results predominantly from the incorporation of dAMP opposite putative apurinic sites. These results have provided an identifying tag for mutagenesis via apurinic sites, and have been used to formulate a model for the role of apurinic sites in both spontaneous and induced mutagenesis.

32799 **(LA-UR—86-1149) Molecular and cellular mechanisms of cadmium resistance in cultured cells.** Grady, D.L.; Moyzis, R.K.; Hildebrand, C.E. (Los Alamos National Lab., NM (USA)). 1985. Contract W-7405-ENG-36. 14p. (CONF-8508108—3). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010163.

From 2. international meeting on metallothionein; Zurich, Switzerland (21 Aug 1985).

Heavy metal induction of the synthesis of metallothioneins (MTs) provides an ideal model system for basic mechanistic studies of gene expression. Cell lines varying in their resistance to heavy metals have been isolated through a regime of exposure to serially increasing levels of Cd followed by clonal isolation. These cell lines have been used to examine the role of methylation and amplification in the Cd-resistant (Cd/sup r/) phenotype. It is suggested that regulation of expression of the MT genes in Cd/sup r/ Chinese hamster cells is modulated at both the transcriptional and translational levels. An analysis of the MT2 gene sequence has uncovered a potential alternative splice site in the first intron. Usage of this site would insert 3 or 12 additional amino acids between amino acids 9 and 10. Analysis of the splicing pattern of the MT2 gene transcript in cultured cells has indicated that the second intron is preferentially removed prior to first intron excision. 34 refs., 2 figs., 1 tab.

32800 **Hemocyanin respiratory pigment in bivalve mollusks.** Morse, M.P.; Meyhoefer, E.; Otto, J.J.; Kuzirian, A.M. (Northeastern Univ., Nahant, MA). *Science (Washington, D.C.);* **231**: No. 4743, 1302-1304(14 Mar 1986). Contract AC02-77EV04580.

Hemocyanins, high molecular weight oxygen-binding proteins, were identified in two species of protobranch bivalve mollusks, Acila castrensis and Yoldia limatula. Although hemocyanins have been reported in chitons, gastropods, and cephalopods, they have not been observed in the Class Bivalvia. In A. castrensis the dissociation products of hemocyanin, characterized by gel electrophoresis, had a subunit molecular weight of approximately 250K. Negatively stained preparations of extracted hemocyanin formed protein aggregates in the shape of cylinders measuring 35 by 38 nanometers. X-ray microanalysis of hemocyanin aggregates in thin sections of Y. limatula demonstrated the presence of copper in the molecules. The discovery of hemocyanin in the protobranchs reinforces the primitive nature of the taxon and is further evidence that the major molluscan classes have a common ancestry. 14 references, 3 figures.

32801 **Base displacement in AAF-modified Z-DNA.** Broyde, S.; Hingerty, B. (New York Univ., NY). *Carcinogenesis (New York);* **6**: No. 1, 151-154(1985). Contract AC02-81ER60015;AC05-84OR21400.

A new model is presented for acetylaminofluorene (AAF)-modified Z-DNA, in which the carcinogen is in a base-displaced position, inserted into the helix interior and parallel with an adjacent base. 18 references, 3 figures.

32802 **New biological dimensions in mass spectrometry.** Busch, K.L.; Glish, G.L. (Indiana Univ., Bloomington). *Biotechniques;* vp(May-Jun 1984). Contract W-7405-ENG-26.

Major advances in the field of mass spectrometry are of significant interest to the biologist searching for new analytical methods. Three frontiers of particular interest are fast atom bombardment (FAB), combined liquid chromatography/mass spectrometry (LC/MS), and mass spectrometry/mass spectrometry (MS/MS). Mass spectra of such large, nonvolatile, and thermally labile compounds as peptides, saccharides, antibiotics, nucleotides, etc. are now obtained routinely. The authors discuss the basis for FAB, LC/MS, and MS/MS and gives examples of each as applied to biological problems. Of special interest is the use of these methods to provide sequence information on small bio-oligomers, including peptides and oligonucleotides. 49 references, 5 figures.

32803 **Nick translation of HeLa cell nuclei as a probe for locating DNase I-sensitive nucleosomes.** Javaherian, K.; Fasman, G.D. (Brandeis Univ., Waltham, MA). *Journal of Biological Chemistry;* **259**: No. 5, 3343-3349(10 Mar 1984).

The technique of nick translation of nuclei has been used in HeLa cells to label DNase I-sensitive regions. Micrococcal nuclease digestion of the nick translated nuclei was followed by a low ionic strength gel electrophoresis system which separates different types of mononucleosomes. The major label was observed in the vicinity of high mobility group protein containing mononucleosomes. However, further analysis revealed that the particle does not sediment in the position of mononucleosomes on a sucrose gradient. Two alternative explanations are discussed as the possible source of this particle. It is either a high mobility group protein containing nucleosome in some unfolded conformation or the labeled particle originates from discrete DNA fragments, wrapped around some nonhistone proteins, located in a highly DNase I-sensitive region, which is resistant to micrococcal nuclease digestion. 36 references, 7 figures.

32804 **Exogenous ecdysteroids elicit low-threshold sensory responses in spiny lobsters.** Spencer, M.; Case, J.F. (Univ. of California, Santa Barbara). *Journal of Experimental Zoology;* **229**: 163-166(1984).

Electrophysiological recordings from chemoreceptors in the lateral antennule of Panulirus interruptus reveal low threshold detection of 10^{-13} M β-ecdysone or 10^{-13} M α-ecdysone with a latency of less than 1 second. Responses to either α- or β-ecdysone were recorded from juvenile, female (with and without spermatophores or bearing eggs), and male lobsters in intermolt and premolt stages. Receptors responding to α-ecdysone did not respond to 2.9 X 10^{-11} M β-ecdysone. The behavioral function of this low threshold detection is not known, but ecdysteroids may be important in intra- or interspecific communication. The short latency of this neural response to ecdysteroids strongly implicates interaction with a membrane-associated component. Thus, the chemoreceptors in the lateral antennule of P. interruptus may provide a valuable system for the study of the affinity and specificity of membrane-bound ecdysteroid receptors for comparison to previously described cytoplasmic and nuclear ecdysteroid receptors and membrane-associated receptors specific for other steroid compounds. 25 references, 1 figure, 1 table.

32805 **Eye pigment granules of Drosophica melangogaster: isolation and characterization for synthesis of sepiapterin and precursors of drosopterin.** Hearl, W.G.; Jacobson, K.B. (Univ. of Tennessee-Oak Ridge Graduate School of Biomedical Sciences). *Insect Biochemistry;* **14**: No. 3, 329-335(1984). Contract W-7405-ENG-26.

A method is described for the isolation of eye pigment granules from heads of Drosophila melanogaster. These granules are characterized by electron microscopy. In these granules certain enzymes that are involved in sepiapterin and drosopterin biosynthesis are present at higher specific activity than the cytosol. When the granules were washed, the phosphatase activity was much less than

that in the cytosol. Ramiopterin synthase, for example, is present in both the granules and cytosol, but has nine times greater specific activity in the former. Also, a procedure is described for preparation of a stable solution of dihydroneopterin triphosphate. The authors suggest that the enzymes for drosopterin synthesis are all contained in the pigment granule. 19 references, 3 figures, 2 tables.

32806 **Inability of [^{3}H]estriol to induce maximal cooperativity of the estrogen receptor.** Sasson, S.; Notides, A.C. (Univ. of Rochester School of Medicine and Dentistry, NY). *Journal of Steroid Biochemistry;* **20**: No. 4B, 1027-1032(1984). Contract AC02-76EV03490.

The interaction of [^{3}H]estriol with the partially purified estrogen receptor from calf uterus shows positive cooperativity that is dependent upon receptor concentration and temperature. At a receptor concentration of 1 nM and 25°C the [^{3}H]estriol-receptor cooperativity was low, the Hill coefficient (n/sub H/) was 1.03 +/- 0.02; however, with increasing receptor concentrations the receptor's cooperativity increased until at approximately intracellular receptor concentration (20 nM) the n/sub H/= 1.20 +/- 0.04. At 0°C and a receptor concentration of 10 nM the [^{3}H]estriol-receptor interaction was highly cooperative, the Scatchard plot was convex and n/sub H/ = 1.58 +- 0.04 while at 30°C the Scatchard plot approached linearity and n/sub H/ = 1.03 +- 0.02. In comparison, [^{3}H]estradiol was capable of inducing, at 0 or 30°C and at a receptor concentration of 1 nM or greater, maximal receptor cooperativity, n/sub H/=1.63. These data demonstrate: (a) the receptor's conformation and binding mechanism change in a specific manner with temperature, so that receptor analysis at 0°C does not necessarily reflect the receptor's properties at biologically relevant temperatures; (b) the dependence of the receptor's cooperativity on receptor concentration, which suggests interaction between dissociable subunits; and (c) the lower cooperativity induced by estriol, in comparison with estradiol, which indicates estriol is less efficient in shifting the receptor toward a higher affinity or the activated state of the receptor. 15 references, 6 figures, 1 table.

32807 **Some perspectives on two-dimensional protein mapping.** Anderson, L.; Anderson, N. (Argonne National Lab., IL). *Clinical Chemistry (Winston-Salem, North Carolina);* **30**: No. 12, 1898-1905(1984).

High-resolution two-dimensional electrophoresis is the only technique currently available which can resolve and map the very complex mixtures of proteins found in cells and body fluids. The authors review briefly the evolution of protein mapping by use of this technique and then discuss five major issues which will be important in the future. These are 1) development of standardized high-throughput computerized mapping systems, 2) application of mapping to the characterization and identification of cells and organisms, 3) development of a flexible standardized nomenclature, 4) the application of artificial intelligence to the analysis of protein data bases, and 5) the use of 2-D mapping for the detection of mutations. The authors conclude that new classes of information can and will be acquired that will be important for understanding both normal cell function and disease.

5504 Genetics

32808 (ANL/CNSV-TM—167, pp 163-173) **Hybridization of DNA from methanogens with eubacterial probes.** Sibold, L.; Pariot, D.; Bhatnagar, L.; Henriquet, M.; Aubert, J.P. (Institut Pasteur, Paris, France). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

By using the Southern hybridization technique, homologies were examined between restricted DNA of Methanobacterium ivanovi, Methanococcus voltae, Methanosarcina barkeri, Methanobacterium thermoautotrophicum strain ΔH and several eubacterial probes. No hybridization was observed with the following genes: Escherichia coli cya (adenylate cyclase), E. coli and Anabaena glnA (glutamine synthetase), Bacillus subtilis gyrAB (gyrase), and Rhizobium japonicum hup (hydrogenase uptake). Positive results were obtained with B. subtilis rRNA genes and Klebsiella pneumoniae and Anabaena nifH genes that code for the subunit of nitrogenase Fe protein. 22 references, 2 figures, 2 tables.

32809 (ANL/CNSV-TM—167, pp 175-186) **Expression of a methanogen gene in Escherichia coli and in Bacillus subtilis.** Morris, C.J.; Reeve J.N. (Ohio State Univ., Columbus). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—). Contract AC02-81ER10945.

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

A DNA sequence has been cloned from Methanosarcina barkeri which complements argG mutations of Escherichia coli and an argA mutation of Bacillus subtilis. Analysis of the polypeptides encoded by this DNA sequence, indicates that the arginine complementing activity is embodied in a 51,000 dalton polypeptide. This polypeptide is synthesized in both E. coli and B. subtilis minicells. Deletions and Tn5 insertions have been introduced into the cloned M. barkeri DNA to delineate the DNA sequence which encodes the polypeptide. The direction of transcription and translation of the cloned gene has been determined by analysis of polypeptides synthesized in minicells containing plasmids with deletions and insertions. 19 references, 4 figures, 1 table.

32810 (ANL/CNSV-TM—167, pp 187-193) **Antibiotic G418 for selection and maintenance of pro- and eukaryotic transformants and its possible application for methanogen transformation.** Feldman, D.; Ho, N.W.Y. (Purdue Univ., West Lafayette, IN). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Antibiotic G418, an aminoglycoside antibiotic, is structurally related to kanamycin, gentamycin, and neomycin. The antibiotic is known to block protein synthesis in both eukaryotic and prokaryotic cells, and a wide variety of organisms including yeasts and plants are known to be sensitive or moderately sensitive to this antibiotic. Furthermore, G418, similar to kanamycin and other related antibiotics, can be inactivated by bacterial phosphotransferases encoded by the kanamycin and neomycin resistant genes. To date, the km/sup R/ and neo/sup R/ genes have been used as genetic markers for the selection of G418-resistant transformants from yeast, plant, and mammalian cells. This paper reports that antibiotic G418 can also inhibit the growth of a number of methanogenic bacteria, particularly Methanobacterium thermoautotrophicum and Methanococcus mazei. Hence, antibiotic G418 might also be useful as a selective agent for the development of a transformation system for those species of methanogens that are sensitive to this antibiotic. Experiments are currently in progress in our laboratory to explore such a possibility. 14 references.

32811 **Cloning and expression of the gene for bacteriophage T7 RNA polymerase.** Davanloo, P.; Rosenberg, A.H.; Dunn, J.J.; Studier, F.W. (Brookhaven National Lab., Upton, NY). *Proceedings of the National Academy of Sciences of the United States of America;* **81**: 2035-2039(Apr 1984).

The complete coding sequence of the gene for bacteriophage T7 RNA polymerase (T7 gene 1) has been cloned in the plasmid pBR322. Large amounts of active enzyme can be accumulated in Escherichia coli when the cloned gene is transcribed from the lac UV5 promoter. A protease activity that apparently can nick the protein without causing it to fall apart can be a problem during purification, but a procedure is described that gives good yields of essentially homogeneous, highly active enzyme suitable for biochemical and physical studies. T7 RNA polymerase has a stringent specificity for its own promoters and will selectively transcribe DNA that has been linked to such a promoter. This specificity makes the enzyme useful both for producing specific RNAs in vitro and for directing the expression of selected genes inside the cell. Having the cloned gene also makes possible a detailed mutational analysis of the functioning of T7 RNA polymerase. 25 references, 3 figures.

32812 **Cloning in Streptococcus pneumoniae of the gene for DpnII DNA methylase.** Lacks, S.A.; Springhorn, S.S. (Brookhaven National Lab., Upton, NY). *Journal of Bacteriology;* **157**: No. 3, 934-936(Mar 1984).

The gene coding for the pneumococcal DNA adenine methylase that recognizes the sequence 5'-GATC-3' was cloned in a strain of Streptococcus pneumoniae that lacked both restriction endonucleases DpnI and DpnII. The gene was cloned as a 3.7-kilobase fragment of chromosomal DNA from a DpnII-containing strain inserted in both possible orientations in the multicopy plasmid vector pMP5 to give recombinant plasmids pMP8 and pMP10. Recombinant plasmids were selected by their resistance to DpnII cleavage. Cells carrying the recombinant plasmids modified phage in vivo so that it was restricted by DpnI- but not DpnII-containing hosts. They also showed levels of DNA methylase activity five times higher than that in cells of the original DpnII strain. No DpnII activity was observed in the clones; therefore, it was concluded that the insert did not contain an intact DpnII endonuclease gene and that methylation of host DNA did not turn on a latent form of the gene. 16 references, 1 figure, 2 tables.

32813 **Examination of the mitochondrial genome of revertant progeny from S cms maize with cloned S-1 and S-2 hybridization probes.** Kemble, R.J.; Mans, R.J. (Univ. of Florida, Gainesville). *Journal of Molecular and Applied Genetics;* **2**: No. 2, 161-171(1983). Contract AS05-81ER10904.

The authors have examined the molecular rearrangement of mitochondrial DNAs in each of several fertile revertants that arose spontaneously from S-type cytoplasmically male-sterile maize. Cloned segments of S-1 and S-2 DNAs were hybridized to untreated and restriction endonuclease-treated mitochondrial DNAs from fertile plants carrying normal cytoplasm, from cytoplasmically male-sterile plants, and from plants that had cytoplasmically reverted to fertility. The relative intensity of hybridization with S-1 and S-2 probes was different among the fertile, sterile, and revertant lines. The sizes of some restriction endonuclease fragments from the fertile revertant lines that hybridize with the S-2 probe differ from those of the sterile parental lines. Preferential synthesis of high molecular weight components of the mitochondrial genome carrying S-1 and S-2 sequences, concomitant with cessation in apparent autonomous replication of discrete S-1 and S-2 DNAs and their replicative intermediates, could accommodate the hybridization data. The results suggest but do not prove that S-2 sequences are transposed coincident with the sterile plant's reversion to fertility. The inserted segments could arise from sequences already present in the high molecular weight DNA or from the lower molecular weight linear components of the mitochondrial geonome. Putative target sites of insertion of S-1 and S-2 sequences would be multiple and separate for each. Reversion of S-type cytoplasmically male-sterile plants to fertility does not restore the organization of the mitochondrial genome to that of a normal fertile plant.

5505 Metabolism

REFER ALSO TO CITATION(S) 32823

32814 **(DOE/EV/10091—2) Response of a hardwood forest to carbon dioxide and climate change. Final progress report.** Gates, D.M. (Michigan Univ., Ann Arbor (USA). Biological Station). Mar 1986. Contract AC02-79EV10091. 7p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010133.

Data were collected on the gas exchange of major species found in northern hardwood forests. These data include daily time-course of photosynthesis and transpiration, temperature responses, light responses, and CO_2 responses. Results of analyses show it is possible to simulate with good accuracy photosynthesis of individual leaves. (ACR)

32815 **Comparison of ethanolamine and potassium hydroxide as quantitative trapping agents for radiolabeled CO_2 in metabolism studies.** Medinsky, M.A. (Inhalation Toxicology Research Institute, Albuquerque, NM). *Journal of Analytical Toxicology;* **10**: No. 1, 24-27(Jan-Feb 1986).

The efficiency of ethanolamine and potassium hydroxide (KOH) as trapping agents for CO_2 was determined using a flow of 500 mL/min through CO_2 absorption towers containing trapping solution. Radiolabeled $^{14}CO_2$ was produced by acidification of suspensions containing $Ba^{14}CO_3$. Both 100% ethanolamine and 5M ethanolamine in 2-methoxyethanol were evaluated. With 200 mL of either solution, trapping efficiency of $^{14}CO_2$ decreased when only 5% or less of the amount of ethanolamine available had reacted (22 mmoles of CO_2) trapped). In contrast, use of 200 mL of 1M or 5M KOH was effective in retaining 88 mmoles of CO_2. This is equivalent to the amount of CO_2 produced by a rat over an 8-hr period. In summary, with flow rates commonly used in in vivo metabolism studies, the trapping efficiency of ethanolamine was far less than the theoretical efficiency. In these types of studies KOH would be a more suitable trapping agent or, if used, ethanolamine solutions must be changed frequently.

32816 **Lipid peroxidation model for halogenated hydrocarbon toxicity. Kinetics of peroxyl radical processes involving fatty acids and Fe(III) porhyrins.** Brault, D.; Neta, P.; Patterson, L.K. (Museum National d'Histoire Naturelle, Paris, France). *Chemico-Biological Interactions;* **54**: 289-297(1985).

The toxicity of halogenated alkanes originates from their metabolism by cytochrome P-450 which leads to the formation of reactive intermediates. In particular, peroxyl radicals derived from the halogenated compounds are believed to induce peroxidative chain degradation of lipids. To examine this hypothesis, radical reactions in a system involving Fe^3-deuteroporphyrin as a model of cytochrome P-450, fatty acids or cholesterol, and carbon tetrachloride or the anesthetic agent halothane are studied by means of pulse radiolysis. It is shown that haloperoxyl radicals react with the fatty acids in competition with their reaction with the ferriporphyrin. Moreover, the secondary fatty acid peroxyl radicals also react efficiently with the porphyrin. A model for halogenated alkane toxicity is discussed in terms of these new findings. The importance of local oxygen concentration and structural arrangement of fatty acids around cytochrome P-450 are emphasized. 17 references, 2 figures, 1 table.

5506 Medicine

REFER ALSO TO CITATION(S) 32337, 32393, 33097

32817 **(BNL—37795) Proposal for a new tomographic device providing information on the chemical properties of a body section.** Gatti, E.; Rehak, P.; Kemmer, J. (Brookhaven National Lab., Upton, NY (USA); Beschleunigerlaboratorium der Univ. und Technischen Univ. Muenchen, Garching (Germany, F.R.)). 27 Feb 1986. Contract AC02-76CH00016. 68p. (CONF-8603109—3). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010547.

From 4. European symposium on semiconductor detectors; Munich, F.R. Germany (3 Mar 1986).

A system to analyze the chemical properties of a region of tissue located deep inside the human body without having to access it is proposed. The method is based on a high precision detection of x-rays or γ-rays (photons) from an external source Compton scattered from the tissue under inspection. The method provides chemical information of plane regions lying not too deep inside the body (<6 cm). The amount of radiation absorbed by the body is about the same as needed for a standard x-ray tomography. The exposure time is estimated to be shorter than 10 minutes. 37 refs., 13 figs.

32818 (DOE/ER/40048—102-L4, pp 66-67) **Fast neutron beam radiotherapy: clinical program.** Laramore, G.E. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Twenty-six patients have been placed on RTOG neutron protocols during the reporting period. A breakdown of patients by protocol is given in tabular form. New finding with respect to lung, prostate and sacoma protocols are summarized.

32819 (DOE/ER/40048—102-L4, pp 68-69) **Neutron radiobiology in support of radiotherapy.** Rasey, J.S. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The Experimental Biology Division of the Department of Radiation Oncology continues to perform radiobiology experiments in support of the radiotherapy of human cancer with fast neutrons. Patient treatment with the 22 MeV d+Be neutron beam from the nuclear physics laboratory cyclotron ceased in February, 1984. Patient treatment will begin shortly with the 48 MeV p+Be neutron beam from the Clinical Neutron Therapy System (CNTS) at the University Hospital. Their studies in the past year have been directed toward determining the relative biological effectiveness (RBE) of the 22 MeV beam relative to the 48 MeV beam. The RBE for the 22 MeV d+Be neutron beam relative to ^{137}Cs gamma rays has been determined using cell survival in V79 cells in vitro and two in vivo systems, acute response of mouse skin and survival of mouse intestinal crypt cells. The RBEs obtained with these three systems at various dose levels are summarized.

32820 (DOE/ER/40048—102-L4, pp 69) **Normal tissue neutron radiobiology.** Mahler, P.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The author is currently conducting experiments to gain information about the new therapy beam by using damage to rat spinal cord as a measure of the beam's relative biological effectiveness (RBE). Using ^{137}Cs gamma rays, 22 MeV d+Be neutrons from the Nuclear Physics Laboratory and 48 MeV p+Be neutrons from the new hospital cyclotron the will determine the doses to produce equal levels of spinal cord damage.

32821 (DOE/ER/40048—102-L4, pp 70) **Effect of antibiotic decontamination of the GI tract on survival time after neutron and gamma irradiation.** Geraci, J.P.; Jackson, K.L.; Mariano, M.S. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Antibiotic decontaminated and conventional rats were whole-body irradiated with 8 MeV neutrons (1.5 to 13 Gy) or ^{137}Cs gamma radiation (9 to 20 Gy). The animals were checked for survival at four hour intervals from the second to the seventh day postirradiation and at eight hour intervals on other days. Decontamination of the GI tract increased median survival time 1 to 5 days in this range of dose dependency, whereas the effect of decontamination was negligible for doses that produced mostly intestinal death. These results suggest that sepsis and endotoxin produced by bacteria from the intestinal tract play little role in acute intestinal radiation death.

32822 (DOE/ER/40048—102-L4, pp 70-71) **Measurement of total body calcium by neutron activation.** Chesnut, C.H.; Lewellen, B.L.; Murano, R. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The authors have now completed 15 years using neutron activation to measure total body calcium in patients with bone wasting disease. In the past year they have performed 88 patient irradiations. Two therapeutic regimes were under test. Under the first regime, patients were treated with 1,25 dihydroxy calciferol (vitamin D). Under the second regime, patients who had been treated with disodium chlodronate were followed after withdrawal of the drug. In both studies, an equal number of untreated control subjects were followed and many other tests were performed as well as neutron activation. Since June, 1982 the authors have also been measuring the bone mineral in the lumbar spine by the dual photon absorption technique developed by Mazess of the University of Wisconsin and applied extensively by Wahner and Riggs of the Mayo Clinic.

32823 (DOE/ER/60039—T2) **[Development of gamma-emitting, receptor-binding radiotracers for imaging the brain and pancreas]. Progress report, March 1, 1985-February 1, 1986.** Reba, R.C. (George Washington Univ., Washington, DC (USA)). 1986. Contract AS05-82ER60039. 5p. NTIS, PC A02. File Number DE86010296.

We have been investigating the uses of 3-quinuclidinyl 4-iodobenzilate (4IQNB) as an imaging agent for the quantitation of muscarinic acetylcholine receptors (m-AChR) in vivo. Our distribution studies have indicated that localization of 4IQNB in the CNS is reduced compared to QNB as the result of systemic losses probably due to the increase in lipophilicity caused by introduction of iodine. 3 figs., 1 tab.

32824 (DOE/ER/60084—5) **Development of a new osmium-191-iridium-191m radionuclide generator. Annual report.** Treves, S.; Packard, A.B. (Children's Hospital Medical Center, Boston, MA (USA). Dept. of Radiology). 30 Apr 1986. Contract AC02-82ER60084. 46p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010371.

The major limitation of the Cheng generator design is the chemical instability of the parent trans-dioxotetrachloroosmate(VI) complex. Efforts reported here were directed towards the evaluation of alternative osmium complexes for use as the parent species. Several non-chloro osmium complexes were synthesized that proved to be promising for generator applications and ^{191}Os-/sup 191m/Ir generators were subsequently developed using these complexes as the parent species. One of these generators ("oxalate") was found to be particularly promising and has been optimized for potential human use (IND application pending). Although the "oxalate" generator provides twice the /sup 191m/Ir yield and less than one-tenth the ^{191}Os breakthrough of earlier designs, the yield of the generator remains low (30%/mL) and decreases with time to 15 to 20%/mL. 16 refs., 16 tabs.

32825 (DOE/ER/60176—2) **Radiochemical studies using a 42 MeV cyclotron. Final report, September 1, 1983-February 28, 1986.** Tilbury, R.S.; Kolar, A.J. (Texas Univ., Houston (USA). System Cancer Center). 1986. Contract AS05-83ER60176. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010130.

The cyclotron is working well for neutron production and has been used in the past year for radiation therapy of patients and radiobiology experiments. Good progress has been made with three projects described here. 13 irradiations on the University of Texas Health Science Center cyclotron have been used for the production of bromine radioisotopes and Ba-131, which have been used in these studies.

32826 (DOE/ER/60176—2, pp 5-14) **Production of Ba-131/Cs-131 for use in radiotherapy implants. Project 3.** 1986. NTIS, PC A03/MF A01. File Number DE86010130. Contract AS05-83ER60176.

In Radiochemical studies using a 42 MeV cyclotron. Final report, September 1, 1983-February 28, 1986.

The conditions for the irradiation of anhydrous cesium chloride have been determined for 40 MeV proton beam currents up to 5 microamps. A method for the chemical separation of Ba-131 from the irradiated target material has been developed using chelex-100 ion exchange resin. The elution of Cs-131 from the column has been achieved using 0.2M NH_4Cl solution, which can be evaporated to dryness, the NH_4Cl sublimed off, and the Cs-131 obtained as a no-carrier added solid free of other ions, suitable for incorporation into glass or ceramic seeds. 3 refs., 2 figs., 1 tab.

32827 (DOE/ER/60176—2, pp 15-29) **Preparation of C-II labeled pyruvic acid for use in assessment of hypoxia in tumors. Project 4.** 1986. NTIS, PC A03/MF A01. File Number DE86010130. Contract AS05-83ER60176.

In Radiochemical studies using a 42 MeV cyclotron. Final report, September 1, 1983-February 28, 1986.

Of the three methods of synthesis of C-II-labeled pyruvic acid that we had proposed to investigate in order to determine the best and most appropriate synthesis of C-II-labeled pyruvate, the cold chemistry of Method A, via an isocyanide intermediate, has

been verified. Similarly, the cold chemistry of Method B, via the 1,3-dithiane derivative, has been verified up to the deprotection and last step of the synthesis. The difficulties which have been encountered with the biochemistry of Method C from ribulose 1,5-diphosphate, have yet to be resolved. 12 refs., 6 figs.

32828 (DOE/ER/60176—2, pp 30-43) **Labeled radiosensitizers for assessment of their use in radiotherapy. Project 5.** 1986. NTIS, PC A03/MF A01. File Number DE86010130. Contract AS05-83ER60176.

In Radiochemical studies using a 42 MeV cyclotron. Final report, September 1, 1983-February 28, 1986.

Bromine-77 with a half-life of 57 hours was produced on the University of Texas Health Science Center Cyclotron and transported to M.D. Anderson Hospital for use in labeling experiments. The chemistry of two different bromine substituted derivatives of misonidazole (1-(2-nitro-1-imidazoly)-3-methoxy-2-propanol) was investigated. A sample of 4-(Br-77)-bromomisonidazole was synthesized and used to image a dog with an adenocarcinoma of the mammary glands. 12 refs.

32829 (DOE/EV/10359—4) **Quantitative studies in radiopharmaceutical science. Progress report, January 1-December 31, 1983.** Beck, R.N.; Cooper, M.D. (Franklin McLean Memorial Research Inst., Chicago, IL (USA)). Sep 1983. Contract AC02-80EV10359. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010375.

A brief overview is provided of studies performed by the investigators concerning the use of radiopharmaceuticals in medicine. 10 refs., 3 figs. (DT)

32830 (DOE/EV/10359—6) **Nuclear medicine and imaging research. Quantitative studies in radiopharmaceutical science. Comprehensive progress report, January 1, 1983-June 30, 1985.** Beck, R.N.; Cooper, M.D. (Franklin McLean Memorial Research Inst., Chicago, IL (USA)). Sep 1985. Contract AC02-80EV10359. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010341.

This comprehensive report outlines the progress made during the past three years in the areas described below. In all instances, initial studies have been carried out and the technical feasibility of carrying through each study has been demonstrated. The studies described include development of cesium-130 and bromine-75 radioisotope generators, the feasibility of using rubidium-82 as a myocardial imaging agent, and radiochemical preparation of C-11 deoxyglucose. 28 refs. (DT)

32831 (INIS-mf—9880) **Detection of Met-enkephalin: Development of a RIA and of an extraction method for studies on hypophyseal and brain tissues.** Holl, R. (Ulm Univ. (Germany, F.R.). Fakultaet fuer Theoretische Medizin). 3 Dec 1982. 154p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE86751750.

The thesis describes the development of a method of detecting Met-enkephalin, and the verification of the method's suitability to measurements in extracted tissue. The tissue extraction method reported has been the first step towards the goal of establishing the method for determining Met-enkephalin in cell and tissue extracts, in culture media, plasma and liquor samples. The difficulties involved in the development of the RIA for Met-enkephalin specifically arose from the following peculiarities of the substance: a) Due to the low molecular weight, (574), ME itself does not act as an antigen, antibodies can only be obtained by means of fixation to carrier molecules. b) Enkephalin very rapidly is decomposed by endogenic proteinases. c) The fact that normal physiological processes will produce peptides very similar in sequence requires the RIA to be extremely specific. The method has first been applied to screening measurements of Met-enkephalin concentrations in various brain sectors. The radioimmunological studies have been intended to supplement and verify the immunocytochemical results obtained, with the latter experiments having been made using the same antiserum, in order to improve the basis of comparison between the immunocytochemical results and the findings on antibody specifity obtained from the RIA.

32832 (INIS-mf—10128) **Royal Order of 21 August 1985 amending the Royal Order of 28 February 1963 enacting General Regulations for Protection of the Population and Workers against the Hazards of Ionizing Radiation.** (International Atomic Energy Agency, Vienna (Austria)). 16 Oct 1985. 4p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702093.

Published in Moniteur Belge.

The amendments to the 1963 Royal Order aim to improve the prior licensing procedure for products containing radioisotopes to be used as unsealed sources in human or veterinary medicine for "in vivo" or "in vitro" diagnostic purposes and for therapy. They concern, in particular, the preparation of the licensing file, quality control procedures and the laboratories approved to perform such controls. The Ministerial Order of 13th April 1984 which contained similar provisions is revoked.

32833 (INIS-mf—10129) **Statutory instruments: 1984 No. 1261 Medicines - The Medicines (Committee on Radiation from Radioactive Medicinal Products) (Revocation) Order 1984.** (International Atomic Energy Agency, Vienna (Austria)). 6 Aug 1984. 2p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702098.

This Order, which came into force on 6 September 1984, revokes the Medicines (Committee on Radiation from Radioactive Medicinal Products) Order 1978 thereby abolishing the Committee, which was established for the purpose of giving advice on safety, quality and efficacy in relation to radiation involving any substance or article for human use to which the Medicines Act 1968 is applicable.

32834 (NPRU—81/18) **BRA: A Breast Radiation Analysis program.** Keddy, R.J.; Malkin, J.H. (University of the Witwatersrand, Johannesburg (South Africa). Nuclear Physics Research Unit). 1981. 20p. Nuclear Physics Research Unit, University of the Witwatersrand, 1 Jan Smuts Avenue, Johannesburg, 2001, South Africa.

BRA is an acronym for Breast Radiation Analysis. The program has been developed in order to compute the absorbed radiation dosage to the breasts of patients who are subjected to X-ray mammographic examinations or radiation therapy. The computation of the breast volume is inherent in the program and the program can be limited to a volume calculation if so desired. Volumes of masses within the breast can also be computed. Digitised co-ordinates of the breast outline obtained from the cranio-cauded and medio-lateral views are required as input.

32835 **Positron emission tomography of the heart.** Budinger, T.F.; Yano, Y.; Huesman, R.H.; Derenzo, S.E.; Moyer, B.R.; Mathis, C.A.; Ganz, E.; Knittel, B. (Lawrence Berkeley Lab., CA). *Physiologist;* **26**: No. 1, 31-34(1983).

Positron emission tomography (PET) of the heart can measure blood perfusion, metabolism of fatty acids, metabolism of sugars, uptake of amino acids and can quantitate infarction volume. The principles are reviewed which are basic to PET instrumentation and procedures for quantitative studies of human physiology with examples of measurements of myocardial flow and metabolism.

5507 Microbiology

REFER ALSO TO CITATION(S) 31622, 31623, 31624, 31625, 31626, 31628, 31629, 31630, 31643, 32808, 32809, 32810

32836 (ANL/CNSV-TM—167, pp 141-161) **Strategies for the isolation of microorganisms responsible for polyphosphate accumulation.** Suresh, N.; Warburg, R.; Timmerman, M.; Wells, J.; Coccia, M.; Roberts, M.F.; Halvorson, H.O. (Brandeis Univ., Waltham, MA). Dec 1985. NTIS, PC A21/MF A01. File Number DE86007158. (CONF-840824—).

From 1. symposium on biotechnological advances in processing municipal waste for fuels and chemicals; Minneapolis, MN, USA (15 Aug 1984).

Several strategies were used to isolate organisms involved in the uptake and subsequent release of inorganic phosphate from

waste water sludge. These included direct staining for polyphosphates (polyP), growing in ^{32}P inorganic phosphate followed by autoradiography, resistance to dicyclohexyl carbodiimide (DCCD), an ATPase inhibitor, and isolation on the basis of the buoyant density of the cell. Among those microorganisms isolated, three were identified as Acinetobacter lwoffii, A. calcoaceticus and Pseudomonas vesicularis. The P. vesicularis culture had 31% of phosphate as polyP. ^{31}P NMR analysis of the whole cells revealed the presence of polyP when the cultures were grown aerobically to the late stationary phase and its subsequent loss during anaerobic incubation. Loss of polyP was also associated with a decrease in buoyant density of the cell. In the presence of DCCD, there was a decrease in the polyP peak, but a substantial increase in the sugar phosphates which is consistent with a hypothesis that polyP is used as a reserve energy source. P. vesicularis cells showed a two-fold increase in the level of polyphosphatase during early stationary phase, but a thirty-fold increase in polyphosphate kinase activity during late stationary phase. This increased enzyme activity is consistent with the increased polyP synthesis during late stationary phase. 31 references, 7 figures, 3 tables.

32837 **Buoyant density variation during the cell cycle of Saccharomyces cerevisiae.** Baldwin, W.W.; Kubitschek, H.E. (Argonne National Lab., IL). *Journal of Bacteriology;* **158**: No. 2, 701-704(May 1984). Contract W-31-109-ENG-38.

Cell buoyant densities of the budding yeast Saccharomyces cerevisiae were determined for rapidly growing asynchronous and synchronous cultures by equilibrium sedimentation in Percoll gradients. The average cell density in exponentially growing cultures was 1.1126 g/ml, with a range of density variation of 0.010 g/ml. Densities were highest for cells with buds about one-fourth the diameter of their mother cells and lowest when bud diameters were about the same as their mother cells. In synchronous cultures inoculated from the least-dense cells, there was no observable perturbation of cell growth: cell numbers increased without lag, and the doubling time (66 min) was the same as that for the parent culture. Starting from a low value at the beginning of the cycle, cell buoyant density oscillated between a maximum density near midcycle (0.4 generations) and a minimum near the end of the cycle (0.9 generations). The pattern of cyclic variation of buoyant density was quantitatively determined from density measurements for five cell classes, which were categorized by bud diameter. The observed variation in buoyant density during the cell cycle of S. cerevisiae contrasts sharply with the constancy in buoyant density observed for cells of Escherichia coli, Chinese hamster cells, and three murine cell lines. 9 references, 3 figures, 1 table.

5509 Pathology

REFER ALSO TO CITATION(S) 32861, 32866

32838 **Transformation of human cells by DNA transfection.** Sutherland, B.M.; Bennett, P.V. (Brookhaven National Lab., Upton, NY). *Cancer Research;* **44**: 2769-2772(Jul 1984).

Normal human cells can be transformed to anchorage-independent growth by transfection with DNA from MOLT-4 lymphoblasts, derived from a patient with acute lymphocytic leukemia. Cells were treated with polyethylene glycol 6000, and DNA was administered as a calcium phosphate coprecipitate. The transforming activity of MOLT DNA was inactivated by treatment with DNase or by the restriction enzymes Bg/1 or BamHl but not by EcoRV. DNA from transfected colonies can transform human recipient cells to anchorage-independent growth; the transforming ability and anchorage independence are maintained stably for at least 30 generations. 18 references, 4 tables.

32839 **X-ray biomicroholography.** Solem, J.C.; Chapline, G.F. (Los Alamos National Lab., NM). *Optical Engineering;* **23**: No. 2, 193-203(Mar-Apr 1984).

The authors discuss alternative techniques for microholography of biological specimens including requirements and constraints on the optical elements and recording media. The authors derive spatial and temporal coherence requirements for four representative holographic techniques and relate coherence and recording-medium resolution to maximum specimen volume. The authors give estimates of coherence length necessary to image a variety of specimens under a realistic set of assumptions. The authors discuss matters of wavelength selection with emphasis on the problem of obtaining high contrasts for nitrogen-bearing biological constituents. The authors use the eikonal approximation to derive equations for diffractive holographic imaging with particular attention to specimens of low contrast, and use these to illustrate the benefits of using 2 π/sub g/ resonances to image molecular structures. 48 references, 5 figures, 3 tables.

32840 **Inexact reconstructions from projections.** Crewe, A.V.; Crewe, D.A. (Univ. of Chicago, IL). *Ultramicroscopy;* **12**: 293-298(1984).

Images of biological objects formed in the electron microscope are of such a nature that the authors can simplify the problem of three-dimensional reconstruction. One simplification is to make the assumption that the object can be represented as a Boolean three-dimensional matrix. In this paper the authors examine the problem of reconstructing two-dimensional Boolean matrices from their projections and conclude that surprisingly good reconstructions can be obtained using only four projections. 7 references, 4 figures.

5510 Physiological Systems

REFER ALSO TO CITATION(S) 32769

5520 Public Health

REFER ALSO TO CITATION(S) 32718, 32719

32841 **(IPEN-Pub—81) Method for routine determination of fluoride in urine by selective ion- electrode.** Pires, M.A.F.; Bellintani, S.A. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 10p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702021.

A simple, fast and sensitive method is outlined for determining fluoride in urine of workers who handle fluoride compounds. The determination is based on the measurement of fluoride by ion selective electrode. Cationic interferents like Ca^{++}, Mg^{++}, Fe^{+++} and Al^{+++} are complexed by EDTA and citric acid. Common anions present in urine, such as Cl^{-}, PO^{---}_4 and SO^{--}_4 do not interfere in the method.

5530 Agriculture And Food Technology

REFER ALSO TO CITATION(S) 32794

32842 **(TVA/OACD—85/4) National conference on grain marketing patterns.** (Tennessee Valley Authority, Muscle Shoals, AL (USA). Office of Agricultural and Chemical Development). Feb 1985. 396p. (CONF-8103198—). NTIS, PC A17/MF A01. File Number DE86901288.

From National conference on grain marketing patterns; Memphis, TN, USA (11 Mar 1981).

Four papers are given on grain movements in United States, eight papers on the grain and soybean industry, and five papers on the grain transportation industry. (DLC)

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

REFER ALSO TO CITATION(S) 32818, 32860

32843 (DOE/ER/60110—3) Radiological Research Accelerator Facility. Progress report, April 1, 1985-March 31, 1986. Rossi, H.H. (Columbia Univ., New York (USA). Nevis Labs.). Jan 1986. Contract AC02-83ER60110. 46p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010249.

To increase the utilization of RARAF by scientists outside RRL, a RARAF User's Guide was prepared in the spring of 1985. The User's Guide is reproduced as an appendix to this progress report. Since the Guide provides an extensive introduction to RARAF, the introductory material of this report has been kept short. Readers not entirely familiar with RARAF are urged to look through the Guide for information about RARAF's history, facilities, services, staff, Scientific Advisory Committee, and especially its research capabilities and how to plan an experiment at RARAF. 6 refs., 9 figs., 3 tabs..

32844 (ENEA-RT-PAS—85/22) Long-term environmental risk estimation. Dall'aglio, M.; Mastino, G. (ENEA, Casaccia (Italy). Dipartimento Protezione Ambientale e Salute dell'Uomo). Jun 1983. 24p. (CONF-8306279—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86901293.

From ENVRISK '83 - international workshop on environmental impacts of energy systems; San Miniato, Pisa, Italy (1 Jun 1983).

The paper deals with the experience gained in Italy and in other countries in the field of radiological protection and acute environmental effects where some significant result has been gained. In particular, as regards long-term environmental risks, it is advisable to introduce methodologies and approaches such as to provide adequate environmental management based on risk reduction principles.

32845 (JINR—E-19-85-385) Relation between sedimentation behaviour of DNA-membrane complexes and DNA single- and double-strand breaks after irradiation with gamma-rays, pulse neutrons and ^{12}C ions. Erzgraber, G.; Lapidus, I.L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems; Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1985. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702020.

Submitted to the journal Int. J. Radiat. Biol. .

The experimental data on sedimentation behaviour of DNA-membrane complexes at radiation of the Chinese hamster cells (V79-4) in a wide dose range of ^{137}Cs γ-rays, pulse neutrons (reactor IBR-2, Laboratory of Neutron Physics, JINR, Dubna) and accelerated ^{12}C ions (cyclotron U-200, Laboratory of Nuclear Reactions, JINR, Dubna) are presented. An assumption on the role of DNA single- and double-strand breaks in changing the sedimentation properties of DNA-membrane complexes has been confirmed by the experiments with radiation of different quality. The possibility of estimating induction and repair of DNA breaks on the basis of dependence of the relative sedimentation velocity of complexes on the irradiation doses is discussed.

32846 (Juel—2014) Kinetics of sup(99m)Tc labelled RES colloids in man. Herzog, H.; Behrendt, C.; Spohr, G.; Schwarzhoff, V.; Notohamiprodjo, G.; Feinendegen, L.E. (Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Medizin). Aug 1985. 87p. (In German). NTIS (US Sales Only), PC A05/MF A01. File Number DE86751748.

The aim of the research program was to check the biokinetic data by direct, absolute quantification in man. For this purpose appropriate methods of measurement were developed. Liver and spleen activities were directly measured using a double energy window technique. Activities in other organs were quantified by the geometric mean of anterior and posterior whole-body scans. The measurement procedures were checked and compared using the Alderson phantom. Biokinetic data were obtained for the four most widely-used colloids: sulphur colloid, tin colloid, HSA millimicropheres and phytate. For the sulphur colloid three different commercial preparations were compared. The data obtained are based on 13-20 subjects for each type of colloid. All subjects were clinically free from liver disease, infection, and malignancy. The calculated uptake of activity differed significantly from published values, especially in liver and spleen. The liver uptake was between 54% and 75% of the total administered dose (TAD), whereas MIRD Dose Estimate Report Nr. 3 gives a value of 80%. Depending on the colloid type, spleen uptake was up to four times the 5% TAD value given in the MIRD Report. Activity measured in blood, urine, lung and thyroid proved to be far from negligible. The radiation doses to liver and spleen calculated from the biokinetic data measured in man differ from the values published in MIRD Report Nr. 3. The mean calculated liver dose ranges from 49 to 76 μGy/MBq (181 to 283 mrem/mCi), depending on the type of colloid. Phytate yielded the lowest spleen dose, 29 μGy/MBq (107 mrem/mCi). For other colloids the maximum dose was up to 157 μGy/MBq (578 mrem/mCi).

32847 (KFK—4001) Biology of neptunium. Wirth, R.E. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Genetik und Toxikologie von Spaltstoffen; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Bio- und Geowissenschaften). Nov 1985. 159p. (In German). NTIS (US Sales Only), PC A08/MF A01. File Number DE86751729.

This work contains detailed information about fractional absorption of neptunium through gastrointestinal tract in vivo as well as about organ and subcellular distribution in rats. Biochemical investigations have shown, that neptunium is bound to the iron transport protein transferrin in the blood serum. A long-term experiment resulted in osteosarkomincidences of 11% (0.2 mp Np-237/kg) and 36% (1 mg Np-237/kg); simultaneous the whole-body retention was measured during the natural lifespan of the animals of 2.5 years.

32848 (NUREG/CR—4000-Vol.1) Mesorad dose assessment model. Volume 1. Technical basis. Scherpelz, R.I.; Bander, T.J.; Athey, G.F.; Ramsdell, J.V. (Pacific Northwest Labs., Richland, WA (USA)). Mar 1986. Contract AC06-76RL01830. 96p. (PNL—5219-Vol.1). NTIS, PC A05/MF A01 - GPO. File Number TI86009631.

MESORAD is a dose assessment model for emergency response applications. Using release data for as many as 50 radionuclides, the model calculates: (1) external doses resulting from exposure to radiation emitted by radionuclides contained in elevated or deposited material; (2) internal dose commitment resulting from inhalation; and (3) total whole-body doses. External doses from airborne material are calculated using semi-infinite and finite cloud approximations. At each stage in model execution, the appropriate approximation is selected after considering the cloud dimensions. Atmospheric processes are represented in MESORAD by a combination of Lagrangian puff and Gaussian plume dispersion models, a source depletion (deposition velocity) dry deposition model, and a wet deposition model using washout coefficients based on precipitation rates.

32849 (ORNL/M—132) Type B investigation report of curium-244 exposure at the ORNL TRU Facility, January 15, 1986. Love, G.L.; Butler, H.M.; Duncan, D.T.; Oakes, T.W. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 88p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86009590.

This Type B Investigative Report provides an evaluation of relevant events and activities that led to, were a part of, or resulted from the release of curium-244 in the Building 7920 facility at ORNL in January 1986. Impacts have been evaluated with respect to employee exposures and the costs and loss of productivity resulting from increased bioassay analyses and activities of investigative committees. Management systems evaluated include (1) training of employees performing lab analyses, (2) adherence to procedures, and (3) response to unusual circumstances.

32850 (PNL-SA—13789) Mortality studies of Hanford workers. Gilbert, E.S. (Pacific Northwest Labs., Richland, WA (USA)). Mar 1986. Contract AC06-76RL01830. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010218.

The relationships of cancer mortality with radiation exposure as influenced by age, sex, follow-up time length of employment, and job category are discussed in relation to workers at the Hanford facilities. (ACR)

32851 Tritium hazard via the ingestion pathway. Travis, C.C. (Oak Ridge National Laboratory, Oak Ridge, TN). *Fusion Technology;* **8**: No. 2, 2535-2538(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

The classic methodology for estimating dose to man from environmental tritium ignores the fact that organically bound tritium in foodstuffs may be directly assimilated in the bound compartment of tissues without previous oxidation. We propose a four-compartment model that allows for the ability to input organically bound tritium in foodstuffs directly into the organic compartments of the model. We found that organically bound tritium in foodstuffs can increase the total body dose by a factor of 1.7-4.5 times the free body water dose alone, depending on the bound to loose ratio of tritium in the diet.

32852 Genetic complementation between UV-sensitive CHO mutants and xeroderma pigmentosum fibroblasts. Thompson, L.H.; Mooney, C.L.; Brookman, K.W. (Lawrence Livermore National Lab., CA). *Mutation Research;* **150**: 423-429(1985). Contract W-7405-ENG-48.

The purpose of this study was to determine the feasibility of doing complementation analysis between DNA-repair mutants of CHO cells and human fibroblasts based on the recovery of hybrid cells resistant to DNA damage. Two UV-sensitive CHO mutant lines, UV20 and UV41, which belong to different genetic complementation groups, were fused with fibroblasts of xeroderma pigmentosum in various complementation groups. Because the frequency of viable hybrid clones was generally $< 10^{-6}$ and the frequency of revertants of each CHO mutant was $\sim 2 \times 10^{-7}$, putative hybrids required verification. Hybrid clones were obtained from 9 of the 10 different crosses involving 5 complementation groups of XP cells. The 4 attempted crosses with 2 other XP groups yielded no hybrid colonies. Thus, a definitive complementation analysis was not possible. Hybrids were evaluated for their UV resistance using a rapid assay that measures differential cytotoxicity (DC). All 9 hybrids were more resistant than the parental mutant CHO and XP cells, indicating that in each case complementation of the CHO repair defect by a human gene had occurred. 3 hybrids were analyzed for their UV-radiation survival curves and shown to be much more resistant that the CHO mutants but less resistant than normal CHO cells. With 2 of these hybrids, sensitive subclones, which had presumably lost the complementing gene, were found to have similar sensitivity to the parental CHO mutants. The authors conclude that the extremely low frequency of viable hybrids in this system limits the usefulness of the approach. The possibility remains that each of the nonhybridizing XP strains could be altered in the same locus as one of the CHO mutants. 23 references, 2 figures, 1 table.

32853 Radiation carcinogenesis. Kohn, H.I.; Fry, R.J.M. (Harvard Medical School, Boston, MA). *New England Journal of Medicine;* **310**: 504-511(23 Feb 1984). Contract W-7405-ENG-26.

During the past 10 years, investigators of radiation-induced carcinogenesis in human beings have concentrated on continuing the follow-up of populations previously studied and on collating and reanalyzing all available data. Although these approaches may not seem exciting in comparison to what has been going on in molecular biology, they are essential for two simple reasons. First, there are very few populations suitable for fruitful study, and it is unlikely that additional ones will become available. Second, it has become clear that in many types of cancer, not even 30 years of follow-up are adequate to show the total effect of exposure. In this review we shall summarize the principal epidemiologic findings and the inferences that can be drawn from them, and then discuss them in relation to current work in experimental radiation biology. 115 references.

32854 Repair of neoplastic transformation damage following protracted exposures to ^{60}Co γ-rays. Han, A.; Hill, C.K.; Elkind, M.M. (Argonne National Lab., IL). *British Journal of Cancer, Supplement;* **49**: 91-96(1984). Contract W-31-109-ENG-38.

The incidences of neoplastic transformation induced by ^{60}Co γ-rays in exponentially growing mouse embryo 10T1/2 cells were measured following acute and protracted exposures. Delivery of ^{60}Co γ-rays at a low dose rate (0.1, 0.5, 2.5 cGy min^{-1}) compared with a high dose rate (100 cGy min^{-1}) results in appreciable, dose rate dependent reductions in cell killing and, independent of the effect on cell survival, reduces significantly the incidence of neoplastic transformation. Exposure of exponentially growing 10T1/2 cells to a dose of γ-rays in 5 equal daily fractions also significantly reduces transformation frequency, compared with delivery in a single dose, throughout the dose range examined (25-300 cGy). The initial parts of the induction curves are fitted quite well by a linear dose dependence. The slopes of the regression lines for multifractionation delivery or irradiation at 0.1 cGy min^{-1}, are one-third and one-half, respectively, of those for single exposures at a high dose rate. Increasing the inter-fraction interval up to 48 h, or reduction of the dose per fraction further reduce incidence of neoplastic transformation. The authors conclude that protracted exposures of low LET radiation result in a net error-free repair of subtransformation damage. 12 references, 4 figures, 1 table.

5603 Chemicals Metabolism And Toxicology

REFER ALSO TO CITATION(S) 31313, 31349, 31384, 31414, 32377, 32767, 32778, 32816, 32841, 33492

32855 (CONF-860626—1) Use of pharmacokinetics in risk analysis. Travis, C.C. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 11p. NTIS, PC A02. File Number DE86010033.

From 20. annual conference on trace substances in environmental health; Columbia, MO, USA (2 Jun 1986).

Quantitative risk assessment for carcinogenic chemicals is usually based on data obtained in animal studies conducted at very high levels of exposure. A key issue in using such data is extrapolation of the results from animals to man. Recently, physiological pharmacokinetic (P-P) models have been used to improve the accuracy of such extrapolations. Model results for inhalation of tetrachloroethylene will be presented and compared to experimental data for rats and humans. Scaling physiological parameters allowed us to successfully extrapolate results from rats to humans.

32856 (DOE/ER—0243) Anaerobic microbial transformations in subsurface environments: highlights. Francis, A.J. (Brookhaven National Lab., Upton, NY (USA)). Sep 1985. Contract AC02-76CH00016. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86008703.

Anaerobic microorganisms under appropriate conditions affect trace metal dissolution and mobilization or immobilization in the subsurface environments by one or more of the following processes: (1) changes in pH and Eh (which affect the valence or ionic state of the metals and enhance their mobility in the subsurface environment by retarding the subsoil binding characteristics); (2) chelation or production of specific sequestering agents (solubilization and leaching of certain elements by microbial metabolites or decomposition products); and (3) bioaccumulation and release of metals due to remineralization elsewhere in the environment.

32857 Isolation of a highly mutagenic aminophenanthrene from a coal gasification process tar. Haugen, D.A.; Stamoudis, V.C.; Peak, M.J.; Boparai, A.S. (Argonne National Lab., IL). *Environmental Research;* **39**: No. 1, 60-73(1986). Contract W-31-109-ENG-38.

A major portion of the mutagenic activity associated with products and by-products of coal conversion can be ascribed to nitrogen-containing bases. The authors improved the extraction effi-

ciencies for three- to five-ring aromatic bases by extracting them with a mixture of methanol and aqueous HCl, rather than with aqueous HCl alone. A complex mutagenic basic fraction of a coal gasification process tar was successively fractionated using cation exchange and reversed phase high-performance liquid chromatography. The fractions were assayed for mutagenic activity and were chemically analyzed by gas chromatography and gas chromatography-mass spectrometry. Aminophenanthrenes were identified as major contributors to the mutagenicity of the basic fraction. Aminonaphthalenes, aminobiphenyls, and their alkyl homologs were also present but were not detected as principal mutagens.

32858 **Effects of sulfuric acid mist inhalation on mucous clearance and on airway fluids of rats and guinea pigs.** Wolff, R.K.; Henderson, R.F.; Gray, R.H.; Carpenter, R.L.; Hahn, F.F. (Inhalation Toxicology Research Institute, Albuquerque, NM). *Journal of Toxicology and Environmental Health;* **17**: No. 1, 129-142(1986). Contract AC04-76EV01013.

The responses of guinea pigs and rats to inhaled sulfuric acid aerosols were compared to define species differences and to determine the small-animal model most relevant to human exposures. Rats were exposed for 6 hr to 1, 10, and 100 mg H_2SO_4/m^3. Guinea pigs were exposed for 6 h to 1, 10, and 27 mg H_2SO_4/m^3. Tracheal mucous clearance of guinea pigs was slowed 1 d after exposures to 1 mg H_2SO_4/m^3. A tendency toward faster clearance was observed at high concentrations of H_2SO_4 for both guinea pigs and rats (statistically significant only for the rats). The speeding of mucous clearance was correlated with increases in airway sialic acid and also with the appearance of excess tracheal secretions, detected using scanning electron microscopy in both rats and guinea pigs. The responses of guinea pigs to sulfuric acid exposures were more similar to those reported for humans than were those of rats.

32859 **Biological availability of nickel arsenides: cellular response to soluble Ni_5As_2.** Gurley, L.R.; Valdez, J.G.; Miglio, J.J.; Cox, S.H.; Tobey, R.A. (Los Alamos National Lab., NM). *Journal of Toxicology and Environmental Health;* **17**: No. 1, 101-117(1986).

It has been determined that particulate Ni_5As_2 that might be produced during oil-shale retorting could be mobilized to the environment and made available to the cells of living organisms, including humans. Particulate Ni_5As_2 was found to be 12 times more soluble in culture growth medium than in distilled water, and much more soluble in solutions of amino acids, inorganic salts, organic constituents of culture medium, and 15% calf serum. These observations suggest Ni_5As_2 particles in airborne dust would be dissolved when they came in contact with the biological fluids of the lung and gastrointestinal tract. The availability to cells of the soluble products of Ni_5As_2 was demonstrated by measuring its effects on cell proliferation. As little as 1 ppm soluble Ni_5As_2 retarded Chinese hamster (CHO) cell proliferation in culture, and 4 ppm resulted in cell death. Flow cytometry measurements indicated there was a preferential cytotoxic effect on S-phase cells. Despite this, many cells survived to form colonies, causing cell generations. This did not appear to be the case, however, for no mutations could be detected at the hypoxanthine-guanine phosphoribosyl transferase (HGPRT) locus in cells that survived the cytotoxic effects.

32860 **Defective DNA cross-link removal in Chinese hamster cell mutants hypersensitive to bifunctional alkylating agents.** Hoy, C.A.; Thompson, L.H.; Mooney, C.L.; Salazar, E.P. (Lawrence Livermore National Lab., CA). *Cancer Research;* **45**: 1737-1743(Apr 1985). Contract W-7405-ENG-48.

DNA repair-deficient mutants from five genetic complementation groups isolated previously from Chinese hamster cells were assayed for survival after exposure to the bifunctional alkylating agents mitomycin C or diepoxybutane. Groups 1, 3, and 5 exhibited 1.6- to 3-fold hypersensitivity compared to the wild-type cells, whereas Groups 2 and 4 exhibited extraordinary hypersensitivity. Mutants from Groups 1 and 2 were exposed to 22 other bifunctional alkylating agents in a rapid assay that compared cytotoxicity of the mutants to the wild-type parental strain, AA8. With all but two of the compounds, the Group 2 mutant (UV4) was 15- to 60-fold more sensitive than AA8 or the Group 1 mutant (UV5). UV4 showed only 6-fold hypersensitivity to quinacrine mustard. Alkaline elution measurements showed that this compound produced few DNA interstrand cross-links but numerous strand breaks. Therefore, the extreme hypersensitivity of mutants from Groups 2 and 4 appeared specific for compounds the main cytotoxic lesions of which were DNA cross-links. Mutant UV5 was only 1- to 4-fold hypersensitive to all the compounds. Although the initial number of cross-links was similar for the three cell lines, the efficiency of removal of cross-links was lowest in UV4 and intermediate in UV5. These results suggest that the different levels of sensitivity are specifically related to different efficiencies of DNA cross-link removal. The phenotype of hypersensitivity to both UV radiation and cross-link damage exhibited by the mutants in Groups 2 and 4 appears to differ from those of the known human DNA repair syndromes.

32861 **Acute effects of cigarette smoke exposure on experimental skin flaps.** Nolan, J.; Jenkins, R.A.; Kurihara, K.; Schultz, R.C. (Univ. of Illinois Medical Center, Chicago). *Plastic and Reconstructive Surgery;* **75**: No. 4, 544-549(Apr 1985). Contract W-7405-ENG-26.

Random vascular patterned caudally based McFarlane-type skin flaps were elevated in groups of Fischer 344 rats. Groups of rats were then acutely exposed on an intermittent basis to smoke generated from well-characterized research filter cigarettes. Previously developed smoke inhalation exposure protocols were employed using a Maddox-ORNL inhalation exposure system. Rats that continued smoke exposure following surgery showed a significantly greater mean percent area of flap necrosis compared with sham-exposed groups or control groups not exposed. The possible pathogenesis of this observation as well as considerations and correlations with chronic human smokers are discussed. Increased risks of flap necrosis by smoking in the perioperative period are suggested by this study.

32862 **Carcinogenic responses to chemicals applied directly to rat mammary glands in situ.** Holtzman, S.; Meade, M.; Stone, J.P.; Shellabarger, C.J. (Brookhaven National Lab., Upton). *Carcinogenesis (New York);* **6**: No. 5, 769-772(1985). Contract AC02-76CH00016.

In four experiments, concentrated glycerin suspensions of 7,12-dimethylbenz[a]anthracene (DMBA), or the water-soluble compounds, N-methyl-N-nitrosourea (MNU), N-ethyl-N-nitrosourea (ENU), and 4-nitroquinoline-N-oxide (4-NQO) were delivered into pockets in the mammary fat pads in female Sprague-Dawley rats. In a 90-day experiment, each of three groups of 20-22 rats were treated with either 25, 50, or 100 μg DMBA delivered to each of four sites in each rat per group. Dose-related responses were detected for incidence of rats with mammary adenocarcinoma (MAC), and for number of MAC per treated site. In a 120-day study, each of three groups of 20 animals were treated with either 250, 500, or 1000 μg MNU at each of 80 sites per group. Dose-related MAC responses were detected for incidence of rats with MAC, number of MAC per treated site, and time to detection of MAC. In two experiments of 90 days duration, groups of 20 females were treated with either 1000 μg ENU or 1000 μg 4-NQO at each of 80 sites per group. ENU produced a total of 27 MAC sites in 65% of the rats, and 4-NQO produced a total of 26 MAC in 60% of the rats. A comparison of the time to detection of all MAC data for the three water-soluble compounds at the 1000 μg treatment level, or on the basis of moles per treatment, yielded a carcinogenic potency relationship of 4-NQO > ENU > MNU. 21 references, 2 figures, 1 table.

32863 **Particles and macrophages in murine Peyer's patches.** LeFevre, M.E.; Warren, J.B.; Joel, D.D. (Brookhaven National Lab., Upton, NY). *Experimental Cell Biology;* **53**: 121-129(1985). Contract AC02-76CH00016.

Mice were given 1% suspensions of 5 insoluble particles (chrysotile asbestos, quartz, carmine, carbon, and iron oxide) in drinking water for 3 months. The particles were subsequently sought in intestinal Peyer's patches by light microscopy. Carbon and iron oxide particles were visible in Peyer's patch macrophages, particularly in the subepithelial region, but the other particles could not be detected. The findings suggest that particle surface properties as well as particle size govern accumulation in Peyer's patches. The cytochemistry of sub-epithelial, mid-dome, tingible-body, and serosal macrophages of control mice indicated diversity of macro-

phages within the patch. Macrophages of asbestos-fed mice contained more lysosomes than macrophages of controls. Macrophage abundance in the dome apex was not significantly altered by asbestos ingestion. The other particles did not produce detectable alterations in macrophage morphology. 24 references, 7 figures.

32864 **Sigmoidally constrained maximum likelihood estimation in quantal bioassay.** Schmoyer, R.L. (Oak Ridge National Lab., TN). *Journal of the American Statistical Association;* 79: No. 386, 448-453(Jun 1984). Contract W-7405-ENG-26.

In quantal bioassay, doses $x_1, \ldots,$ x/sub k/ of a test substance are administered to $n_1, \ldots,$ n/sub k/ animal subjects. Let PI(x) denote the probability that an arbitrary subject responds in a specified way to a dose x. In this article the authors consider maximum likelihood estimation of $PI(x_1), \ldots,$ PI(x/sub k/) subject to the constraint that PI is sigmoid. Of particular interest is the nature of PI at very small x. Upper confidence bounds for PI(x), $x \leqq x_1$, are discussed. These confidence bounds depend on an inequality that holds when PI is convex on $[0, x_1]$. A test of concavity against the alternative under sigmoidicity, and related tests are discussed. Rejecting concavity requires evidence that PI is convex on $[0, x^1]$. 10 references, 1 figure, 2 tables.

32865 **Antidotal efficacy of tetraethylenepentamine for acute nickel carbonyl poisoning in rats.** Jones, D.C.; May, P.M.; Williams, D.R.; Reid, M.C.; Sunderman, F.W. Jr. (Univ. of Wales Institute of Science and Tech., Cardiff). *Inorganica Chimica Acta;* 91: L51-L53(1984). Contract AC02-76EV03140.

The authors developed a computer technique for simulating chelation therapy; the technique generates Plasma Mobilization Index curves that are superior to Effective Stability Constants as predictors of in vivo chelation activity. The present report describes a practical application of the computer simulation technique; tetraethylenepentamine (TEP) was identified by its Plasma Mobilization Index curves as a promising agent for therapeutic complexation of Ni[II]. The prediction that TEP has antidotal efficacy in nickel poisoning was verified by a pilot trial in rats exposed to inhalation of nickel carbonyl, $Ni(CO)_4$.

32866 **Influence of elastase-induced emphysema and the inhalation of an irritant aerosol on deposition and retention of an inhaled insoluble aerosol in Fischer-344 rats.** Damon, E.G.; Mokler, B.V.; Jones, R.K. (Inhalation Toxicology Research Institute, Albuquerque, NM). *Toxicology and Applied Pharmacology;* 67: 322-330(1983). Contract AC04-76EV01013.

The purpose of this study was to assess the effects of elastase-induced pulmonary emphysema and the inhalation of an irritant aerosol (Triton X-100, a nonionic surfactant similar to those used in a number of pressurized consumer products) on pulmonary deposition and retention of an insoluble test aerosol, ^{59}FE-labeled Fe_2O_3. Untreated rats or rats pretreated by intratracheal in stillation with elastase were exposed to an aerosol of ^{59}Fe-labeled Fe_2O_3 either 18 hr or 7 days after exposure to aerosslized Triton X-100 which was administered in doses of 20, 100, or 200 $\mu g/g$ of lung. Rats pretreated with elastase had significantly lower pulmonary deposition of ^{59}Fe than the untreated controls ($p < 0.005$). Pulmonary deposition of Fe_2O_3 was unaffected by pretreatment with Triton X-100. Elastase treatment alone had no effect on retention of Fe_2O_3. Triton X-100 administered 18 hr prior to exposure of rats to Fe_2O_3 aerosol resulted in dose-related increases in whole-body retention of ^{59}Fe. When rats were exposed to Triton X-100 7 days before exposure to Fe_2O_3, increased retention of ^{59}Fe was noted only in those treated at the highest Triton X-100 dose level (200 $\mu g/g$). 20 references, 5 tables.

5604 Other Environmental Pollutant Effects

32867 **Edaphic and crop production changes resulting from pipeline installation in semiarid agricultural ecosystems.** Zellmer, S.D.; Taylor, J.D.; Carter, R.P. (Argonne National Lab., IL). pp 181-189 of Bridging the gap between science, regulation, and the surface mining operation. Princeton, WV; American Society for Surface Mining and Reclamation (1985). (CONF-851012—).

From National meeting of the American Society for Surface Mining and Reclamation; Denver, CO, USA (8 Oct 1985).

The effects of pipeline installation on soil properties and crop production are being documented on three transects (pipe ditch, working side, and control) at four sites (dryland row crop, native pasture, dryland wheat, and irrigated cropland) in Beaver County, Oklahoma. Plant-cover data from the native pasture site show a 37% increase in cover on the pipe ditch during the initial growth season; no significant differences in cover were observed when the control and working side transects were compared. Wheat yield on the pipe ditch at the irrigated crop site was significantly higher, a fact attributed to increased moisture-retention capacity and lower bulk density of the pipe ditch soil. The significantly higher grain sorghum yield on the right-of-way at the dryland row crop site may have resulted from the reclamation practice of chisel plowing the right-of-way on croplands following pipeline construction. Data from the initial sampling and first year of monitoring of the Beaver County sites indicate pipeline installations in semiarid agro-ecosystems have either positive or negligible impacts on soil properties and crop production. 22 references, 1 figure, 3 tables.

32868 **Attempts to produce taste-aversion learning in rats exposed to 60-Hz electric fields.** Creim, J.A.; Lovely, R.H.; Kaune, W.T.; Phillips, R.D. (Pacific Northwest Lab., Richland, WA). *Bioelectromagnetics (New York);* 5: 271-282(1984).

A measure of taste-aversion (TA) learning was used in three experiments to 1) determine whether exposure to intense 60-Hz electric fields can produce TA learning in male Sprague-Dawley rats, and (2) establish a dose-response function for the behavior in question. In Experiment 1, four groups of eight rats each were distributed into one of two exposures (69 +/- 5 kV/m or 133 +/- 10 kV/m) or into one of two sham-exposure groups. Conditioning trials paired 0.1% sodium saccharin in water with 3 h of exposure to a 60-Hz electric field. Following five conditioning trials, a 20-min, two-bottle preference test between water and saccharin-flavored water failed to reveal TA conditioning in exposed groups. In Experiment 2, four groups of eight rats each (34 +/- 2 kV/m or 133 +/- 10 kV/m and two sham-exposed groups) were treated as before. Electric-field exposure had no effect on TA learning. Experiment 3 tested for a possible synergy between a minimal dose (for TA learning) of cyclophosphamide (6 mg/kg) and 5 h of exposure to 133 +/- 10 kV/m electric fields in a dark environment under conditions otherwise similar to those of Experiments 1 and 2. The results indicated no TA learning as reflected in the relative consumption of saccharin. 16 references, 6 figures, 1 table.

58 GEOSCIENCES

REFER ALSO TO CITATION(S) 32690

5801 Geology And Hydrology

REFER ALSO TO CITATION(S) 33469

32869 (LALP—82-30, pp 48-49) **Geology of waste management.** Feb 1983. NTIS, PC A06/MF A01. File Number DE83015241. Contract W-7405-ENG-36.

In Los Alamos National Laboratory annual report, 1982.

Los Alamos, the United States Geologic Survey, Lawrence Livermore National Laboratory, and Sandia National Laboratories are jointly investigating the suitability of Yucca Mountain, located near the southwestern corner of the Nevada Test Site, for such a

repository. The objective of the work, performed as part of the Nevada Nuclear Waste Storage Investigations, is to determine whether a combination of technology and geologic features can create a virtually risk-free system to contain radioactive waste until it poses no harm. Our role is to establish part of the scientific basis for determining whether this site is suitable for a repository. During the year, we have provided further confirmation that Yucca Mountain is appropriate. One additional aspect of our work is an investigation of the hazards of future volcanism. Our work, now largely completed, shows that the hazards of future volcanic activity with respect to waste disposal at Yucca Mountain are extremely low. This conclusion is based on a method of hazard assessment developed here using a combination of geologic studies, age-dating techniques, geochemical studies, probability determinations, and assessment of the consequences of repository disruption by renewed volcanism.

32870 **(SAND—85-0854) Effect of percolation rate on water-travel time in deep, partially saturated zones.** Peters, R.R.; Gauthier, J.H.; Dudley, A.L. (Sandia National Labs., Albuquerque, NM (USA)). Feb 1986. Contract AC04-76DP00789. 51p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010308.

The Nevada Nuclear Waste Storage Investigations (NNWSI) project is investigating Yucca Mountain, Nye county, Nevada, as a prospective site for a radioactive-waste repository. The Yucca Mountain site is unique among those currently being investigated by the US Department of Energy (DOE) in that the prospective repository location is in the unsaturated zone, approximately 300 m above the water table. The rock units at Yucca Mountain can be grouped into three types: (1) vitric tuffs with high matrix conductivity and few fractures; (2) zeolitized tuffs with low matrix conductivity and few fractures; and (3) densely welded tuffs with low matrix conductivities and many fractures. The prospective repository zone is in densely welded tuff; the units between it and the water table are of types 1 and 2. Current percolation rates through Yucca Mountain, and those that are currently postulated under future climatic conditions, are thought to be of the order of the saturated matrix conductivity of some of the units. Although it is probable that there is now little or no water movement in fracture, it is necessary to investigate the potential for fracture flow, especially that which could be initiated under future climatic conditions. Significant fracture flow, if present, could reduce the water travel time between the repository and the water table. A composite-porosity, continuum model was developed to model flow in a fractured, porous medium. Simulations using data from the Yucca Mountain site and this model in the one-dimensional code TOSPAC indicate that current estimates of the percolation rate result in water movement confined to the matrix and that the water-travel time from the repository to the water table is on the order of hundreds of thousands of years. this result is sensitive to the percolation rate; an increase in percolation rate of a factor of 10 many initiate water movement in the fractures, reducing the travel time significantly.

32871 **(TVA/ONRED/AWR—85/34) Floods on Pope and Town Creeks and Tributary No. 1 to Lookout Creek at mile 18.91 in Dade County and Trenton, Georgia.** (Tennessee Valley Authority, Knoxville (USA). Office of Natural Resources and Economic Development). Oct 1985. 69p. NTIS, PC A04/MF A01. File Number DE86901266.

This flood hazard information report describes the extent and severity of the flood potential along selected reaches of Pope Creek, Town Creek, and Tributary No. 1 to Lookout Creek at stream mile 18.91 in Dade County and Trenton, Georgia.

32872 **Rubidium-strontium geochronologic systematics in igneous contact zones: analog for ^{90}Sr and ^{137}Cs behavior in the near field.** Brookins, D.G. (Univ. of New Mexico, Albuquerque). pp 573-582 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The behavior of ^{90}Sr and ^{137}Cs in the near field of a HLW package can be investigated by use of Rb-Sr geochronologic information from igenous contact zones. The chemical behavior of ^{90}Sr is identical to other Sr isotopes, and Cs behavior is very similar to that of Rb. During igneous intrusion, the effect of heat from the igneous rock, coupled with fluid action, is to perturb Rb-Sr systematics of minerals in the intruded rock. Rb-Sr redistribution diagrams are useful not only for indirectly dating the time of intrusion, but also for determining the extent of closed versus open system conditions in the contact zones. Once open or closed system behavior is determined, the Rb-Sr systematics can be evaluated in terms of diffusion, fluid-induced metasomatism, selective dissolution, other, and coupled processes. All these can be discussed in terms of time-temperature-fluid compositional parameters. Rb migration is controlled predominantly by fluid flow; while diffusion models better explain some Sr isotopic behavior Cs, from geochemical arguments, should be less mobile than Rb. In most cases, even when temperature of the intrusive is 800 to 1200°C the cooling period on the order of 10^4 to 10^5 years, and in a highly convective system, Sr and Rb mobility is on the order of only microns to meters. 17 ref.; 2 figs., 1 tab.

5802 Geophysics

REFER ALSO TO CITATION(S) 31400, 31894, 32488, 32491, 32494, 32498, 32499, 32504, 32687, 32884

32873 **(AD-A—164357/6/XAB) Design of a space-based sensor to predict the intensity and location of earthquakes from electromagnetic radiation. Master's thesis.** Whyms, M.L. (Naval Postgraduate School, Monterey, CA (USA)). Dec 1985. 84p. NTIS, PC A05/MF A01.

A proposed design for a space-based sensor to predict and detect earthquakes is presented. A free-standing radiofrequency noise measurement and recording system is described to research the correlation between earthquakes and increased background electromagnetic noise at 30.45 MHz and 150.75 MHz.

32874 (CONF-8510118—, pp 152-160) **1983 Borah Peak, Idaho earthquake - a review of seismicity, surface faulting and regional tectonics.** Richins, W.D. (Idaho National Engineering Lab., Idaho Falls). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The October 28, 1983 Borah Peak, Idaho earthquake (M/sub s/ = 7.3) occurred in an area of low historic seismicity within east-central Idaho along a segment of the Lost River fault active during the Holocene. A dense network of portable short period seismographs (up to 45 stations, station spacings of 2 to 10 km) was installed beginning several hours after the main shock and operated for 22 days. In addition to records from the portable instrumentation, data from permanent seismograph stations operating in Idaho, Utah, Montana, Oregon, Washington, and Wyoming, provide a good regional data base. No foreshock activity above magnitude 2.0 (M/sub L/) was detected for the two month period preceding the main shock. The distribution of 421 aftershocks of M/sub L/ > 2 defines an epicentral pattern, 75 km x 15 km, trending north-northwest parallel to the surface rupture but displaced laterally southwest by 5 to 10 km. The epicenter of the main shock is approximately 14 km south-southwest of the end of surface faulting. This relationship suggests unilateral rupture propagating to the northwest. Aftershocks extend to depths of approximately 16 km and in the southeastern portion of the aftershock pattern define a zone, dipping approximately 45 ° SW, that intersects the surface near the fault scarp. The entire aftershock zone as observed during the first 3.5 weeks was active shortly after the main shock occurred. Fault plane solutions indicate predominantly normal faulting with varying components of strike slip.

32875 (CONF-8510118—, pp 161-168) **Ground motions by microtremor and earthquake observations in relation to damages of the Central Japan Sea Earthquake (M = 7.7), May 26, 1983.** Nogoshi, M. (California Institute of Technology, Pasadena). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The Central Japan Sea Earthquake (M = 7.7, JMA) of May 26, 1983 occurred off Noshiro, Akita Prefecture, Japan. The results of the damage investigations around Noshiro City, which was damaged greatly, were described in relation to analyses of ground motions by microtremor observations in addition to S-wave velocities of the ground surface and the boring data. The damage investigations were about geological conditions of the ground surface and detailed seismic intensities throughout Noshiro and Akita city. The microtremors (3 components) were compared with the underground structures of three sites which represented the geological and soil conditions and P, S-wave velocities by boring well in detail. The characteristics of the ground motions of 153 sites by spectral types of microtremors suggested that the microtremor observations could also be used to estimate the damages from soil liquefaction in relation to underground structures of soil surface. Furthermore, the evaluation of seismic amplification response of ground motion was discussed by using the observations of aftershocks at 31 sites in Akita City. It was found that the ground response characteristics correspond well to the geological conditions of underground structures and the detailed seismic intensities divided into subareas (250 m x 250 m) in Akita City. 5 references, 19 figures.

32876 (CONF-8510118—, pp 169-176) **Seismic hazard assessment of the Hanford region, Eastern Washington State.** Youngs, R.R.; Coppersmith, K.J.; Power, M.S.; Swan, F.H. III. (Geomatrix Consultants, San Francisco, CA). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

A probabilistic seismic hazard assessment was made for a site within the Hanford region of eastern Washington state, which is characterized as an intraplate region having a relatively low rate of seismic activity. Probabilistic procedures, such as logic trees, were utilized to account for the uncertainties in identifying and characterizing the potential seismic sources in the region. Logic trees provide a convenient, flexible means of assessing the values and relative likelihoods of input parameters to the hazard model that may be dependent upon each other. Uncertainties accounted for in this way include the tectonic model, segmentation, capability, fault geometry, maximum earthquake magnitude, and earthquake recurrence rate. The computed hazard results are expressed as a distribution from which confidence levels are assessed. Analysis of the results show the contributions to the total hazard from various seismic sources and due to various earthquake magnitudes. In addition, the contributions of uncertainties in the various source parameters to the uncertainty in the computed hazard are assessed. For this study, the major contribution to uncertainty in the computed hazard are due to uncertainties in the applicable tectonic model and the earthquake recurrence rate. This analysis serves to illustrate some of the probabilistic tools that are available for conducting seismic hazard assessments and for analyzing the results of these studies. 5 references, 7 figures.

32877 (CONF-8510118—, pp 187-193) **Strong ground motion data from the 1983 Borah Peak, Idaho earthquake recorded at the Idaho National Engineering Laboratory.** Jackson, S.M.; Boatwright, J. (EG & G Idaho, Inc., Idaho Falls). Oct 1985. NTIS, PC A11/MF A01. File Number DE86001557.

From DOE's natural phenomena hazards mitigation conference; Las Vegas, NV, USA (7 Oct 1985).

The 1983 Borah Peak, Idaho Earthquake was the largest normal faulting event to occur in the last 20 years. There were no near-field recordings of ground motion during the main shock, however, thirteen accelerographs in a permanent array at the Idaho National Engineering Laboratory (INEL) recorded the event at epicentral distances of 90-110 km. Peak horizontal accelerations (PGA) recorded at accelerographs above ground-floor level range from 0.037 to 0.187 g. Accelerographs at basement and free-field sites recorded as low as 0.022 g and as high as 0.078 g. Peak vertical accelerations range from 0.016 g ground level to 0.059 g above ground floor level. A temporary array of digital seismographs deployed by the US Geological Survey (USGS) in the epicentral area recorded ground motion from six large aftershocks at epicentral distances of 4-45 km; the largest of these aftershocks also triggered four accelerographs in the INEL array. Two separate analyses were used to estimate near-field ground motion. The first analysis uses the attenuation of the aftershock PGA measurements to extrapolate the INEL main shock PGA measurements into the near-field. This estimates an upper limit of 0.8 g for near-field ground motion. In the second analysis, a set of main shock accelerograms were synthesized. Wave propagation effects were determined from aftershock recordings at one of the USGS portable stations and an INEL seismograph station. These effects were removed from one of the INEL main shock acceleration traces. The synthetic accelerograms were derived for a hypothetical station southwest of Mackay, Idaho. The PGA measured from the synthetic accelerograms were 0.08, 0.14, 0.15, 0.23 g. These estimates correlate well with ground motion expected for an area of Intensity VII. 12 references, 8 figures, 1 table.

32878 **(DOE/ID/12079—131) Distribution, lithology and ages of late Cenozoic volcanism on the eastern margin of the Great Basin, West-Central Utah.** Nash, W.P. (Utah Univ., Salt Lake City (USA). Dept. of Geology and Geophysics). 1986. Contract AC07-79ID12079. 88p. (ESL—86007-TR). NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86009898.

The eastern margin of the Basin and Range province in central Utah is the locus of late Cenozoic volcanic activity and has witnessed several volcanic episodes within the last three million years. The Twin Peaks volcanic center became active 2.7 m.y. ago producing rhyodacite and rhyolite from a shallow silicic magma body accompanied by voluminous eruptions of basalt. Between about 1 and 0.3 m.y. ago there were eruptions of high silica rhyolite from a deep-seated magma source beneath the Mineral Mountains together with primitive and strongly fractionated mafic magmas of the Cove Fort subprovince. Within this volcanic area are two localities, Roosevelt Hot Springs and Sulfurdale, which have high temperature waters at or near the surface. To the north in the Black Rock Desert, volcanism extended from 1.5 m.y to only several hundred years ago. The activity was dominated by basaltic eruptions, but the area contains the youngest known rhyolite body in Utah (0.4 m.y.). Volcanic vents are located along major crustal discontinuities in the Black Rock Desert, along ring fracture systems at Twin Peaks, and are aligned along trends of north-south normal faulting in the Mineral Mountains and Cove Fort areas. The localization of volcanism is consistent with high strain rates on a regional scale associated with extension of the Basin and Range. The variety of lithologies observed is consistent with a model of fundamentally basaltic magmatism which augments melting in the lower crust to produce silicic magmas. The majority of the mafic magmas that reach the surface are modified by fractionation with the most primitive varieties erupted to the west.

32879 **(DOE/NV/10270—2-Rev.1) Tectonic stability and expected ground motion at Yucca Mountain. Final report. Revision 1. August 7-8, 1984-January 25-26, 1985.** (Science Applications International Corp., La Jolla, CA (USA)). Dec 1985. Contract AC08-83NV10270. 47p. (SAIC—84/1847-Rev.1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010364.

The historic seismic record at Yucca Mountain is too brief and incomplete to provide an accurate assessment of the frequency/magnitude relationship of the quality required to extrapolate future seismicity. The present northwest-southwest extension rate in the general area of Yucca Mountain appears to be of the same order as that across that entire southern Great Basin averaged over the last 15 million years. Thus, Quaternary tectonic activity can be used as a rough indicator of future activity. In situ stress measurements indicate that failure is possible along favorably oriented faults in the Yucca Mountain region. However, no quantitative statements about earthquake probability and magnitude (M) associated with the failure can be determined from in situ data alone. Both weapons tests at the Nevada Test Site (NTS) and impoundment of water at Lake Mead near Las Vegas have induced or triggered earthquakes of magnitudes as high as 4 or 5 within 14 kilometers of those locations. It is quite likely that all faults with significant scarps indicative of large earthquakes (M/sub s/ $\geq$ 7) during the Quaternary-Holocene have been located and mapped. However, fault segmenta-

tion and the possibility of strike-slip motion complicate the precise identification of active faults and potential fault rupture length. Present estimates of peak ground acceleration at Yucca Mountain are based on empirical relationships that were not specifically derived for normal, oblique-slip, or strike-slip faults within an intraplate extensional regime. Thus, they should be evaluated for application to the Yucca Mountain region, assessed for standard error and uncertainties, and updated with more recent empirical data as appropriate. The Death Valley region is about 50 kilometers from Yucca Mountain. This region may have a potential for producing large earthquakes, but more study is required to assess its earthquake capability.

32880 **(DOE/OR/21552—1) Digital processing of Landsat tm images for lineament occurrence and spatial frequency in sedimentary rocks.** Moore, G.K.; Hastings, D.A. (Geological Survey, Sioux Falls, SD (USA)). 1986. Contract AI05-85OR21552. 33p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86009834.

This report describes and evaluates procedures for the enhancement and extraction of lineament segments by computer processing of digital Landsat Thematic Mapper data. Nearly all results were obtained by convolution of filter windows in the spatial domain. A single procedure was selected as a standard so that results for study areas in South Dakota, Tennessee, Virginia, Wyoming, and small areas of adjacent States could be compared. during the course of the study several new procedures were developed for image enhancement, directional enhancement, and the extraction of edge and line segments from directionally-filtered images; other procedures have previously been described in published literature. The standard procedure proved satisfactory for an extraction of prominent edges and lines in the Landsat images. Part of the problem is caused by the landscape and illumination characteristics of the selected images, but another part is caused by the fact that many boundaries are gradational and do not fit a simple mathematical description of edges and lines. Because of this problem, extracted segments in shale outcrop areas were not compared with those in other types of sedimentary rocks, and measurements of the spatial frequency of occurrence of these segments have a questionable value. A possible solution to the problems found by this study would be: (1) to use a combination of digital elevation data and digital remotely-sensed data of the same area; and (2) to combine directional enhancement and lineament segment extraction with visual detection, screening, and editing. This approach would exploit the main advantages and minimize the disadvantages of both visual and digital analysis.

32881 **(LA-UR—86-785) Seismic monitoring of hydraulic fracturing: techniques for determining fluid flow paths and state of stress away from a wellbore.** Fehler, M.; House, L.; Kaieda, H. (Los Alamos National Lab., NM (USA); Central Research Inst. of Electric Power Industry, Abiko, Chiba (Japan). Technical Lab. No. 2). 1986. Contract W-7405-ENG-36. 9p. (CONF-860609—7). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007365.

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

Hydraulic fracturing has gained in popularity in recent years as a way to determine the orientations and magnitudes of tectonic stresses. By augmenting conventional hydraulic fracturing measurements with detection and mapping of the microearthquakes induced by fracturing, we can supplement and idependently confirm information obtained from conventional analysis. Important information obtained from seismic monitoring includes: the state of stress of the rock, orientation and spacing of the major joint sets, and measurements of rock elastic parameters at locations distant from the wellbore. While conventional well logging operations can provide information about several of these parameters, the zone of interrogation is usually limited to the immediate proximity of the borehole. The seismic waveforms of the microearthquakes contain a wealth of information about the rock in regions that are otherwise inaccessible for study. By reliably locating the hypocenters of many microearthquakes, we have inferred the joint patterns in the rock. We observed that microearthquake locations do not define a simple, thin, planar distribution, that the fault plane solutions are consistent with shear slippage, and that spectral analysis indicates that the source dimensions and slip along the faults are small. Hence we believe that the microearthquakes result from slip along preexisting joints, and not from tensile extension at the tip of the fracture. Orientations of the principal stresses can be estimated by using fault plane solutions of the larger microearthquakes. By using a joint earthquake location scheme, and/or calibrations with downhole detonators, rock velocities and heterogeneities thereof can be investigated in rock volumes that are far enough from the borehole to be representative of intrincis rock properties.

32882 **(PB—86-163110/XAB) Liquefaction of soils during earthquakes. Final report.** (National Research Council, Washington, DC (USA). Committee on Earthquake Engineering). Nov 1985. 223p. NTIS, PC A10/MF A01.

The report reviews the state of knowledge of the causes and effects of liquefaction of soils during earthquakes, documents the state of the art of analysis for safety from liquefaction, and recommends future directions for liquefaction research. It is based on a workshop held in Dedham, Massachusetts, on March 28-30, 1985, at which liquefaction specialists from the United States, Japan, Canada, and the United Kingdom came together to discuss present knowledge and agree on directions for the future. The work was conducted in response to requests from the National Science Foundation and the Nuclear Regulatory Commission.

32883 **Convection in the oceanic crust: Simulation of observations from deep sea drilling project hole 504B, Costa Rica Rift.** Williams, C.F.; Narasimhan, T.N.; Anderson, R.N.; Zoback, M.D.; Becker, K. (Earth Sciences Division, Lawrence Berkeley Laboratory, Berkeley, California). *Journal of Geophysical Research;* **91**: No. B5, 4877-4890(10 Apr 1986).

Three-dimensional modeling of convection in the oceanic crust at Deep Sea Drilling Project site 504B using an integral finite difference model reasonably duplicates underpressures, surface heat flow, downhole temperature profiles, and fluid drawdown rates observed by in situ measurements in the borehole. The major constraint to produce such good fits is the permeability versus depth functions, a quantity which was actually measured in the borehole.

5803 Mineralogy, Petrology, And Rock Mechanics

REFER ALSO TO CITATION(S) 31352, 31459, 31550, 31592, 32302, 32310, 32521, 32686, 32881

32884 **(AECL—8409) Geophysical methods for evaluation of plutonic rocks.** Gibb, R.A.; Scott, J.S. (comps.). (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Apr 1986. 108p. AECL, Chalk River, Ontario KOJ1JO. File Number TI86901265.

Work performed under Canada/US Waste Mangement Information Exchange Agreement.

Geophysical methods are systematically described according to the physical principle and operational mode of each method, the type of information produced, limitations of a technical and/or economic nature, and the applicability of the method to rock-mass evaluation at Research Areas of the Nuclear Fuel Waste Management Program. The geophysical methods fall into three categories: (1) airborne and other reconnaissance surveys, (2) detailed or surface (ground) surveys, and (3) borehole or subsurface surveys. The possible roles of each method in the site-screening and site-evaluation processes of disposal vault site selection are summarized.

32885 **(UCRL—15809) Instrumentation program for rock mechanics and spent fuel tests at the Nevada Test Site.** Pratt, H.R.; Hustrulid, W.H.; Simonson, R. (Terra Tek, Inc., Salt Lake City, UT (USA)). Aug 1978. Contract W-7405-ENG-48. 77p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010557.

This report contains a discussion of an instrumentation and rock mechanics program recommended for consideration as part of the overall Lawrence Livermore nuclear waste storage program at NTS. It includes a discussion of (1) rationale for the heater tests, spent fuel facility evaluation, heated room tests, (2) recommended instrumentation types together with estimated delivery schedules, (3) recommended instrumentation layouts, (4) other proposed rock

mechanics tests both laboratory and in situ, and (5) data acquisition and reduction requirements.

32886 **(UCRL—93412) Analysis and observation of keyblock occurrence in tunnels in granite.** Yow, J.L. Jr. (Lawrence Livermore National Lab., CA (USA)). Feb 1986. Contract W-7405-ENG-48. 9p. (CONF-860609—13). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009719.

From 27. U.S. symposium on rock mechanics; Tuscaloosa, AL, USA (23 Jun 1986).

Tunnels in the granitic climax stock as the Nevada Test Site were inspected for keyblock occurrence. Thirteen relatively large pyramidal keyblocks were located in about 230 m (750 ft) of tunnel. Orientations, dimensions, joint roughness coefficients, and joint compressive strengths were measured for the faces of nine keyblocks. The measurements were used to back-analyze keyblock stability to check the validity of a numerical model for keyblock behavior. A newly developed three-dimensional numerical model correctly predicted whether or not each keyblock failed in six of eight cases. The two exceptions involved stress conditions and keyblock locations that clearly violated the assumptions that underlie the stability model. The observations also allowed the effect of tunnel orientation on keyblock occurrence to be evaluated. Of the thirteen observed keyblocks, nine large blocks were found in less than 30 m (100 ft) of the Piledriver drift (which runs N56E) while only four blocks of comparable size were observed in 200 m (656 ft) of the Spent Fuel Test - climax drift (n61W). The orientations of the keyblock faces were checked against known discontinuity set orientations; some of the faces correlated well with mean set orientations, while other faces were fringe members of sets. Stereographic techniques were used to examine the frequency of keyblock occurrence and to determine the maximum keyblock size that could be encountered with a given combination of discontinuities. Keyblock occurrence was found to be affected by tunnel orientation in a predictable way; this can be used to guide or improve tunnel design practices.

32887 **Some associations of J. C. Jamieson with the shock wave community.** McQueen, R.G. (Los Alamos National Laboratory, Los Alamos, New Mexico). *Journal of Geophysical Research;* **91**: No. B5, 4625-4629(10 Apr 1986).

A brief review is presented of some of the things John Jamieson did while working with people involved with shock wave physics and equation of state at high pressure. This also includes work done on geophysical problems and equation-of-state problems that might not be included in the review articles published in this issue. The subjects covered are some recovery work, studies on rutile and rutile structures, gold standard, flash X ray crystal studies of shocked metals, volume effects on the Gruneisen parameter, equation of state of oxygen, and measurement of Poisson's ratio at high pressure. Although most of these topics are not all directly related to shock wave studies, they all were things that people working in shock wave physics were also investigating or were directly involved with John in his studies.

32888 **Electron microscope study of the stability field and degree of nonstoichiometry in olivine.** Boland, J.N.; Duba, A.G. (Research School of Earth Sciences, Australian National University, Canberra, A. C. T., Australia). *Journal of Geophysical Research;* **91**: No. B5, 4711-4722(10 Apr 1986).

The stability of San Carlos olivine (Fo 90.5) relative to changes in oxygen fugacity at 1300 °C has been determined by studying the microstructural changes in single crystals using transmission and analytical electron microscopy. The first detectable metallic phase, heterogeneously nucleated along dislocations within (100) and (001) subboundaries, had a composition $Ni_{65}Fe_{35}$ equilibrated with a CO/CO_2 gas mixture having an oxygen fugacity f_{O2} of 10/sup -5.6/ Pa. Although the (100) subboundaries contained a high density of dislocations with Burgers vector [100], the nucleation sites were restricted to [010] and [001] dislocations: a result consistent with the theory of heterogeneous nucleation along dislocations. Under the reducing conditions of an f2 of 10^{-12} Pa, a forsteritic olivine is produced at the gas-mineral interface with a high density of metallic precipitates ($Fe_{96}Ni_4$) homogeneously nucleated in the olivine. Nonstoichiometry of the olivine was inferred from the absence of any additional silica-rich phases. The nonstoichiometry was analyzed in terms of possible crystalline defect structures, especially vacancies, assuming no evaporative losses from the surface except an oxygen exchange reaction. On the basis of the model proposed, the highly reduced olivine would contain an excess of SiO_2 (x2 = 0.355 compared with a stoichiometric value of 0.333) from the surface to a depth of several micrometers.

32889 **Analysis of the elastic and strength properties of Yucca Mountain tuff, Nevada.** Price, R.H.; Bauer, S.J. (Sandia National Labs., Albuquerque, NM). pp 89-96 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—). Contract AC04-76DP00789.

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

Yucca Mountain, located near the southwest margin of the Nevada Test Site, in southern Nevada, is being evaluated as a potential site for a nuclear waste repository. Yucca Mountain consists primarily of layered volcanic tuff. Samples from four stratigraphic units have been tested for physical, thermal and mechanical properties as part of the Nevada Nuclear Waste Storage Investigations (NNWSI) Project, administered by the Nevada Operations Office of the U.S. Department of Energy. The four units, in order of increasing depth, are as follows: (1) Topopah Spring Member of the Paintbrush Tuff, (2) Tuffaceous Beds of Calico Hills, (3) Bullfrog Member of the Crater Flat Tuff, and (4) Tram Member of the Crater Flat Tuff. A large data base from more than 100 experiments on drillhole core samples of Yucca Mountain silicic tuff has been assembled for use in NNWSI site evaluation and repository design calculations. These data have been analyzed and empirical expressions were found which relate elastic properties and strength with porosity plus clay content. These relationships will be presented here, in addition to an application of simple elastic composite theory to explain the observed variation of bulk modulus with functional porosity.

32890 **Determination of rock mass deformation modulus during hydraulic fracturing.** Dischler, S.A.; Kim, K. (Rockwell Hanford Operations, Richland, WA). pp 363-376 of Research and engineering applications in rock masses. Volume 1. Ashworth, E. Accord, MA; A.A. Balkema Pub. (1985). (CONF-850671—).

From 26. U.S. symposium on rock mechanics; Rapid City, SD, USA (26 Jun 1985).

This paper presents the results from prototype testing of a new device developed to determine the rock mass deformation modulus during hydraulic fracturing stress measurements. The tool combines a modified U.S. Bureau of Mines borehole deformation gage and standard hydraulic fracturing straddle packers to allow displacement measurements of the borehole wall along three diametrical axes in the pressurized test interval. The deformation modulus is evaluated through utilization of a closed-form elastic solution for a thick-walled cylinder, and the magnitudes and orientations of the in situ stress field are concurrently determined by conventional methods. Enhancement of hydraulic fracturing data interpretation may also be possible by using borehole displacement measurements to monitor induced fracture propagation and improve the definition of breakdown, fracture reopening, and shut-in pressures.

32891 **investigation of the hydrothermal interaction of ^{99}Tc-doped glass with basalt repository nuclear waste package components.** Coles, D.G.; Simonson, S.A.; Thomas, L.E.; Schramke, J.A.; McKinley, S.G. (Pacific Northwest Laboratory, Richland, WA; Westinghouse-Hanford Co., Richland, WA). pp 323-332 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Hydrothermal experiments using basalt-repository nuclear waste package components have been carried out at 200°C and 30 MPa using ^{99}Tc-doped PNL 76 to 68 waste glass. This work was conducted in support of the Basalt Waste Isolation Project. The experiments were carried out in rocking autoclaves that allowed for

periodic solution sampling. Preliminary results that illustrated the effect of basalt on ^{99}Tc solution behavior were discussed previously. In this paper, we continue those observations by discussing the additional experiments that investigated the effects of steel. We also include the post-experiment solid phase analyses from all test configurations. The effects of steel on glass dissolution was observed to be minimal when basalt was not present, i.e., there were no discernible differences in the amount of glass dissolved (based on boron release), with or without steel present. The ^{99}Tc solution concentration results showed that basalt, steel, and a combination of basalt and steel have an ability to dramatically lower the concentration of ^{99}Tc in the solution, probably through a redox mechanism. Solid run product analyses showed that without basalt present, a gel-like secondary phase consisting of an iron, zinc clay with an apparent smectite structure formed. When basalt was present clinoptilolite formed as the major secondary phase, due primarily to the presence of aluminum in the basalt mesostasis. Separation of the various solid run products and residual initial solid phases has not yet been achieved. Such a separation would facilitate the identification of the phase with which ^{99}Tc was associated. The solution results indicated that ^{99}Tc, a potentially mobile radionuclide, may be incorporated in a relatively insoluble phase in the environment of a basalt repository. In addition, no synergistic effects between waste package components were observed that would increase the concentration of ^{99}Tc in solution. 11 refs., 6 figs.

32892 **Permeability changes in crystalline rocks due to temperature: effects of mineral assemblage.** Morrow, C.A.; Moore, D.E.; Byerlee, J.D. (US Geological Survey, Menlo Park, CA). pp 468-474 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The change in permeability with time of granite, quartzite, anorthosite and gabbro was measured while these rocks were subjected to a temperature gradient. The highest temperature (at the heat source) was fixed at 250°C, while low temperatures ranged from 60 to 111°C, depending on rock type. Permeability reductions of up to two orders of magnitude were observed, with the greatest reactions occurring in the quartzite. These changes are thought to be caused by dissolution of minerals at high temperatures, and redeposition of the dissolved material at lower temperatures. Quartz appears to be an important mineral in this self-sealing process. If very low permeability is desired around a nuclear waste repository in crystalline rocks, than a quartz-rich rock may be the most appropriate host. 10 refs., 3 figs., 2 tabs.

32893 **Hydrothermal interaction of Topopah Spring tuff with J-13 water as a function of temperature.** Knauss, K.G.; Delany, J.M.; Beiriger, W.J.; Peifer, D.W. (Lawrence Livermore National Lab., CA). pp 539-546 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract W-7405-ENG-48.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

In support of the Nevada Nuclear Waste Storage Investigations Project experiments were conducted to study the hydrothermal interaction of rock and representative of a potential repository in tuff. These experiments provided data relevant to near-field repository conditions that can be used to: assess the ability to use "accelerated" tests based on the SA/V (surface area/volume) parameter and temperature; allow the measurement of chemical changes in phases present in the tuff before reaction as well as the identification and chemical analysis of secondary phases resulting from hydrothermal reactions; and demonstrate the usefulness of geochemical modeling in a repository environment using the EQ3/6 thermodynamic/kinetic geochemical modeling code. Crushed tuff and polished wafers of tuff were reacted with a natural ground water in Dickson-type gold-cell rocking autoclaves which were periodically sampled under insitu conditions. Results were compared with predictions based on the EQ3/6 geochemical modeling code. Eight short-term experiments (2 to 3 months) at 150°C and 250°C have been completed using tuff from both drillcore and outcrop. Long-term experiments at 90°C and 150°C using drillcore polished wafers are in progress. This paper will focus on the results of the 150°C and 250°C experiments using drillcore polished wafers. 11 refs., 4 figs.

32894 **Geoengineering characterization of welded tuffs from laboratory and field investigations.** Zimmerman, R.M.; Nimick, F.B.; Board, M.P. (Sandia National Laboratories, Albuquerque, NM). pp 547-554 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC04-76DP00789.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Welded tuff beneath Yucca Mountain adjacent to the Nevada Test Site (NTS) is being considered for development as a high-level radioactive waste repository by the Nevada Nuclear Waste Storage Investigations (NNWSI) Project. Because access into Yucca Mountain has been limited to borehole explorations, early geoengineering materials characterizations have been derived from laboratory tests on cores from Yucca Mountain and from laboratory and field tests on welded tuffs located in G-Tunnel on the NTS. G-Tunnel contains welded tuffs that have similar properties and stress states to those at Yucca Mountain and has been the location for in situ rock mechanics testing. The purpose of this paper is to summarize the geoengineering material property data obtained to date and to compare appropriate laboratory and field data from G-Tunnel to findings from Yucca Mountain. Geomechanical and thermal data are provided and are augmented by limited geological and hydrological data. A comparison of results of laboratory measurements on tuffs from Yucca Mountain and G-Tunnel indicates good agreement between the bulk densities, saturations, moduli of elasticity, Poisson's ratios, and P-wave velocities. The G-Tunnel tuff has slightly lower thermal conductivity, tensile strength, compressive strength and slightly higher matrix permeability than does the welded tuff near the proposed repository horizon at Yucca Mountain. From a laboratory-to-field scaling perspective, the modulus of deformation shows the most sensitivity to field conditions because of the presence of joints found in the field. 14 refs., 1 tab.

32895 **Behavior of nuclear waste elements during hydrothermal alteration of glassy rhyolite in an active geothermal system: Yellowstone National Park, Wyoming.** Sturchio, N.C.; Seitz, M.G. (Argonne National Lab., IL). pp 557-564 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The behavior of a group of nuclear waste elements (U, Th, Sr, Zr, Sb, Cs, Ba, and Sm) during hydrothermal alteration of glassy rhyolite is investigated through geochemical analyses of whole rocks, glass and mineral separates, and thermal waters. Significant enrichments of U, Sr, Sb, Cs, and Ba are found in altered rock relative to unaltered rock. Excess Sr, Cs, and Ba are concentrated in zeolites in altered rock. Excess U is associated with titanomagnetite surfaces. Th, Zr, and Sm are relatively immobile during alteration, and are strongly concentrated in celadonite. 19 refs., 2 figs., 2 tabs.

32896 **Chemical implications of heat and radiation damage to rock salt.** Pederson, L.R. (Pacific Northwest Lab., Richland, WA). pp 701-708 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Chemical changes induced in Palo Duro and Paradox Basin natural rock salts and in synthetic NaCl by heat and gamma radiation were investigated. Heating of unirradiated natural rock salts to 300°C resulted in HCl (most prevalent), SO_2, CO_2, and H_2S evolution, and increased the base content of the remaining salt by not more than 10 microequivalents per gram; whereas, heating of synthetic NaCl gave no product. Gamma irradiation produced sodium

colloids and neutral chlorine in amounts similar to the results of Levy and coworkers. When the irradiated salts were heated, three reactions were apparent: (1) radiation-induced defects recombined; (2) neutral chlorine was evolved; and (3) HCl, SO_2, and H_2S were evolved, similar to results for unirradiated salts. Because reaction (1) appeared to dominate over reaction; (2) it is expected that the influence of radiation damage to salt on the near-field chemical environment will be minor. 18 refs., 4 figs., 1 tab.

32897 **Tuff-cement or concrete interactions in the repository environment.** Komarneni, S.; Roy, D.M.; Kumar, A. (Pennsylvania State Univ., University Park). pp 927-934 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Hydrothermal interactions of tuff or tuff minerals with cement or concrete were investigated at 200°C under a confining pressure of 8 or 30 MPa for 1 to 20 weeks. These chemical interactions produced crystalline hydrous calcium silicates such as Al-substituted tobermorite, xonotlite and gyrolite. Tobermorite was the most common interaction product of cement and tuff or tuff minerals because of pozzolanic reaction. The extent of cement hydration and the quantity of cement in the cement mix affected the abundance of tobermorite as expected. The reaction of concrete with tuff resulted in the formation of smectite in addition to tobermorite due to the generation of slight acidic conditions in this reaction mixture under the present hydrothermal conditions. The formation of tobermorite by the interaction of tuff with cement or concrete has positive implications to the physical (bonding) and chemical (sorption) properties in the repository sealing system because tobermorite (Al-substituted) acts both as a binding agent and as a cation exchanger. 15 refs., 4 figs., 4 tabs.

32898 **Dissolution kinetics of tuff rock and mechanism of chemical bond formation at the interface with cement grout.** Malek, R.I.A.; Roy, D.M. (Pennsylvania State Univ., University Park). pp 943-950 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The interaction of tuff rock and cement was studied to evaluate the effectiveness of sealing of tuff boreholes with cementitious grouts. Previous studies indicated chemical bond formation between tuff and cement. Dissolution studies were carried out on Topopah Spring member tuff and on tuff with cement. The results indicate the formation of calcium silicate and calcium aluminosilicate hydrates; phase identification is confirmed by XRD studies. The significance of the results obtained and their implications on properties of the interfacial region are included. 7 refs., 6 figs.

5804 Geochemistry

REFER ALSO TO CITATION(S) 31544, 31555, 32895

32899 **(RHO-BW-ST—76-P) Limitations in determining redox chemistry in basalt groundwaters at the Hanford site.** Dill, J.A.; Jones, T.E.; Marcy, A.D.; West, M.H. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Mar 1986. Contract AC06-77RL01030. 35p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010679.

The oxidation-reduction (redox) chemistry of the basalt groundwater system will be an important factor governing both the design and performance of a high-level nuclear waste repository in basalt. Although the redox state of the basalt groundwater system is inherently difficult to measure, there are a number of types of measurements that provide valuable information on this subject. These measurements include concentrations of dissolved sulfide, ferrous iron, electrode redox potential, and groundwater reducing capacity. These measurements have been made on a limited basis in a number of different repository test horizons. Taken collectively, the results of these measurements suggest that both sulfide and ferrous iron play an important role in the establishment of the basalt groundwater redox condition. Thermodynamic calculations of redox potential (E/sub h/) based on these measurements are indicative of an E/sub h/ of -0.4 V. Additional measurements are proposed that will provide a more complete understanding of basalt groundwater redox conditions. The proposed measurements include a more in-depth analysis of redox active species as well as quantification of dissolved gas species such as oxygen and methane.

32900 **Technetium and neptunium reactions in basalt/groundwater systems.** Meyer, R.E.; Arnold, W.D.; Kelmers, A.D.; Kessler, J.H.; Clark, R.J.; Johnson, J.S. Jr.; Young, G.C.; Case, F.I.; Westmoreland, C.G. (Oak Ridge National Laboratory, TN; Florida State Univ., Tallahassee). pp 333-342 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract AC05-84OR21400.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Sorption isotherms and apparent concentration limits for Tc(VII) and Np(V) for a variety of groundwater/basalt systems were determined using Grande Ronde basalt samples representative of the Hanford Site candidate high-level waste repository. Under oxic redox conditions (air present), little or no sorption of technetium was observed; neptunium exhibited low to moderate sorption ratios. Under anoxic redox conditions (oxygen-free), low to moderate sorption of technetium was often observed, but the extent of sorption was highly dependent upon the groundwater composition and the method of pretreatment (if any) of the basalt. Sorption isotherms for technetium under reducing redox conditions (hydrazine added) indicate an apparent concentration limit of approximately 10^{-6} mol/L Tc. No apparent concentration limit was found for neptunium for concentrations in groundwater up to $\sim 10^{-6}$ mol/L and 8×10^{-7} mol/L under oxic and reducing (hydrazine added) redox conditions, respectively. Valence control and valence analysis experiments suggest that the sorption or precipitation of Tc and Np from groundwater in the presence of basalt may result from a heterogeneous reaction occurring on the surface of the basalt. One of the critical factors of this reduction reaction appears to be the accessibility of the reactive ferrous iron component of the basalt. The laboratory simulation of groundwater redox conditions representative of the repository environment through the use of solution phase redox reagents is of questionable validity, and information obtained by such experimental methods may not be defensible for site performance assessment calculations. Anoxic experiments conducted in an argon-filled glove box appear better suited for the laboratory simulation of in situ redox conditions. 15 refs., 6 tabs.

32901 **Thermodynamics and geochemistry of Ca, Sr, Ba, and Ra sulfates in some deep brines from the Palo Duro Basin, Texas.** Melchoir, D.; Langmuri, D.; Rogers, P.S.Z.; Hubbard, N. (Earth Technology Corp., Long Beach, CA; Colorado School of Mines, Golden, CO; Los Alamos National Labs., NM; Battelle Memorial Inst., Columbus, OH). pp 483-489 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The work reported here involved application of the ion-interaction approach of Pitzer to model the activities of some major and minor cations and major anions in deep brine systems at elevated temperatures and pressures. The solubilities of anhydrite ($CaSO_4$), gypsum ($CaSO_4.2H_2O$), celestite ($SrSO_4$), barite ($BaSO_4$), and radium sulfate ($RaSO_4$) in brines from the Wolfcamp Formation and granite wash facies, Palo Duro Basin, Texas, were modeled using ion-interaction equations. Waters with ionic strengths ranging from 2.89 to 4.76 m, and temperatures and pressures up to 40°C and 130 bars were sampled from five hoizons in three wells, at depths between 970 and 1,670 meters. Theoretical solubility products as a function of temperature and pressure were obtained for comparison with ion activity products computed using ion-interaction theory. The effect of temperature on model calculations was found to reside almost entirely in the Debye-Hueckel A/sub

phi/ parameter, which accordingly was corrected for brine temperatures. Modeling results indicated that all five brines are saturated with respect to anhydrite and celestite, and three of the five with respect to barite. Saturation may result from hydrologic connection with adjacent overlying evaporite units, or increased Ca, Sr, and Ba concentrations caused by their desorption from clays. Radium concentrations, which range from 10^{-}/sup 11.3/ to 10^{-}/sup 12.7/ m, are not controlled by $RaSO_4$ solubility or adsorption, but probably by solid solution in other sulfate minerals in these low pH (4.4 - 6.3) high calcium (0.18 - 0.52 m) brines. 23 refs., 1 fig., 2 tabs.

32902 **Extension of the EQ3/6 computer codes to geochemical modeling of brines.** Jackson, K.J.; Wolery, T.J. (Lawrence Livermore National Laboratory, CA). pp 507-514 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—). Contract W-7405-ENG-48.

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

Recent modifications to the EQ/6 geochemical modeling software package [1-3] provide for the use of Pitzer's [4] equations to calculate the activity coefficients of aqueous species and the activity of water. These changes extend the range of solute concentrations over which the codes can be used to dependably calculate equilibria in geochemical systems, and permit the inclusion of ion pairs, complexes, and undissociated acids and bases as explicit component species in the Pitzer model. Comparisons of calculations made by the EQ3NR and EQ6 computer codes with experimental data confirm that the modifications not only allow the codes to accurately evaluate activity coefficients in concentrated solutions, but also permit prediction of solubility limits of evaporite minerals in brines at 25°C and elevated temperatures. Calculations for a few salts can be made at temperatures up to ~300°C, but the temperature range for most electrolytes is constrained by the availability of requisite data to values ≦ 100°C. The implementation of Pitzer's equations in EQ3/6 allows application of these codes to problems involving calculation of geochemical equilibria in brines; such as evaluation of the chemical environment which might be anticipated for nuclear waste canisters located in a salt repository. 26 refs., 3 figs., 1 tab.

32903 **Actinide microdistributions within monazite.** Jalajas, E.W.; Kaufman, A.; Ku, T.L. (Univ. of Southern California, Los Angeles; Weizmann Inst. of Science, Rohovot, Israel). pp 693-700 of Scientific basis for Nuclear Waste Management VIII. Jantzen, C.M.; Stone, J.A.; Ewing, R.C. (eds.). Pittsburgh, PA; Materials Research Society (1984). (CONF-841157—).

From Materials Research Society annual meeting; Boston, MA, USA (26 Nov 1984).

The results of an induced fission track mapping study of uranium in 12 pegmatitic monazite samples indicate that as the U concentration in monazite surpasses ca. 300 to 400 ppm, the microdistribution becomes much less homogeneous resulting in localized areas of very high uranium concentration (hot spots) in a phase undetectable by XRD. Microprobe analysis of three additional pegmatitic monazites shows the occurrence of exsolution of the two other endmembers of the monazite solid-solution series, huttonite and cheralite, as indicated by a normative mineralogy computed from the probe data. The presence of each mineral is confirmed by XRD. Also supporting this exsolution hypothesis is a strong similarity between ratios of the structural elements of monazite (LREE, P) within the Th-rich hot spots as compared to these ratios in the surrounding monazite. Gradational contacts between banded monazite and a Th-rich phase can be observed microscopically as well as through microprobe scans for Th, indicating the close genetic relationship of the two phases. To prevent their enhanced leachabilities, actinide redistribution must be prevented in any single- or multiphase nuclear waste form. 21 refs., 1 fig., 3 tabs.

32904 **Petrology and geochemistry of Hawaiite lavas from Crater Flat, Nevada.** Vaniman, D.T.; Crowe, B.M.; Gladney, E.S. (Los Alamos National Lab., New Mexico). *Contributions to Mineralogy and Petrology;* **80**: 341-357(1982). Contract W-7405-ENG-36.

Hawaiite-type lavas were erupted in three cycles (3.7, 1.2, and 0.3 M.y.) at Crater Flat, Nevada. The compositions of all three cycles, considered together, form a "straddling" alkalic series as defined by Miyashiro, in which the less evolved basalts plot near the normative olivine-diopside divide and the more evolved basalts project into hypersthene or nepheline fields. Fractionation modeling based on the oldest cycle allows the removal of olivine, clinopyroxene, and amphibole to arrive at the more evolved hawaiite compositions. In general, fractionation of phlogopite or feldspar is limited by the fractionation modeling and by Eu/REE relations. In detail, all hawaiites within one cycle (3.7 M.y.) need not be derived from a single parent magma. Varied parentage is more evident between cycles although all cycles are consistently of hawaiite composition. Basalts of the youngest two cycles are generally enriched in trace elements. Superimposed on this enrichment is a lack of Rb variation, leading to Rb/Sr ratios far lower than required to generate the high $^{87}Sr/^{86}Sr$ ratio (0.707) typical of basalts in this region. The very low Rb/Sr ratios limit processes that may lead to trace-element enrichment during magma evolution (cyclic recharge of a fractionating magma chamber). Decreased fractions of mantle melting leaving phlogopite in the residuum or an earlier event of metasomatic transport from phlogopite-bearing mantle rocks into a phlogopite-absent mantle assemblage might explain the observed trace-element enrichment with low Rb/Sr.

5805 Oceanography

REFER ALSO TO CITATION(S) 31519, 31520, 31521, 31522, 31523, 31524, 31525, 31526, 31527, 31528, 31529, 31530, 31531, 31532, 31533, 31534, 31535, 31536, 31537, 31538, 31539, 31540, 31541, 31542, 31543, 31544

32905 **(UCRL—15775) Long-term climate change in observed physical properties of the oceans.** Barnett, T.P. (Scripps Institution of Oceanography, La Jolla, CA (USA)). 1985. Contract W-7405-ENG-48. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009706.

Changes in key ocean variables have been poorly documented over space and time. Temperature, sea level, salinity, and density are each discussed in terms of their importance to the climate system and society, their measurement problems and the availability of data, and their time variability over recent decades. (ACR)

64 PHYSICS I

REFER ALSO TO CITATION(S) 32792

6401 Astrophysics And Cosmology

REFER ALSO TO CITATION(S) 33025, 33105

32906 **(CBPF-NF—059/85) Study by synchrotron radiation of the superstructure of tetrataenite from the Saint-Severin meteorite.** Tagai, T.; Takeda, H.; Tokinami, M.; Danon, J. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1985. 3p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701971.

Tetrataenite is one of the FeNi minerals which is found in meteorite. The ordering state of Fe/Ni atoms in tetrataenite is determined, because it is closely connected with the thermal history of meteorite.

32907 **(CBPF-NF—061/85) Magnetic properties of tetrataenite-rich meteorites. Pt. 2.** Nagata, T.; Funaki, M.; Danon, J. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1985. 49p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86701935.

Magnetic hysteresis and thermomagnetic characteristics of St. Severin (LL_6), Appley Bridge (LL_6) and Tuxtuac (LL_4) chondrites, which contain tetrataenite in their metallic components, are measured and analyzed in comparison with another tetrataenite-rich chondrite, Yamato 74160. The magnetic properties of tetrataenite-rich meteorites are characterized by (a) high magnetic coercive force (H sub(C)) which amounts to 520 Oe for St. Severin and 160

Oe for Appley Bridge, (b) essential flatness up to about 500°C and then a sharp irreversible drop down to Curie point of the first-run heating thermomagnetic curve. Both characteristic features are broken down to the ordinary features of disordered taenite by a breakdown of tetrataenite structure at elevated temperatures beyond the order-disorder transition temperature. The natural remanent magnetization (NRM) of tetrataenite-rich meteorites is extremely stable against AF-demagnetization and other magnetic disturbances because of the high magnetic coercivity of tetrataenite. The breakdown processes of ordered tetrataenite structure by heat treatments are experimentally pursued for the purpose of research of a possible formation process of tetrataenite phase in meteorites.

32908 **(CBPF-NF—063/85) Weyl (integrable) spacetimes as a model for our cosmos.** Oliveira, L.A.R. de. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701953.

A discussion on Weyl (integrable) spacetimes as a viable model for our cosmos, and on the physical implications for systems non-minimally coupled to gravity is presented.

32909 **(CBPF-NF—064/85) On the differential equation of the cosmic ray's nucleonic component with distribution of elasticity.** Oliveira Castro, F.M. de. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1985. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701954.

The differential equation of cosmic ray's nucleonic component is integrated with distribution of elasticity.

32910 **(CBPF-NF—066/85) Solid state transformations in Fe-Ni alloys from meteorites in powder form.** Scorzelli, R.B.; Danon, J.; Silva, E.G. da. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro; Minas Gerais Univ., Belo Horizonte (Brazil)). 1985. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701936.

Moessbauer studies by transmission and back-scattering technics, with Cape York and Santa Catharina meteorites in powder form are reported. Martensitic transformation upsilon-phase to α-phase is induced by mechanical treatment and long-range order is affected.

32911 **(CBPF-NF—071/85) Exact solution of the nucleons diffusion equation with increase inelastic cross section.** Portella, H.M. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1985. 18p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701955.

The successive approximations method is applied to obtain an exact and compact analytical solution of the differential equation wich describes the diffusion of nucleonic component in the atmosphere, when the inelastic cross section of the air interaction nucleon-nucleus increases with the energy. The result is compared with the experimental data wich have been obtained in Chacaltaya ($x=540 g/cm^2$) by the Brazil - Japan cooperation using emulsion chambers. The value of the constant a measurement of the variation of the cross section with the energy, that makes the best adjustment of the result found out with the experimental data is between 0.05 and 0.06.

32912 (DOE/ER/40048—102-L4, pp 1-2) **Gamma-ray lines from SS433.** Bodansky, D.; Norman, E.B. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The interpretation of observed gamma-ray lines from the astronomical source SS433 was examined in the light of gamma-ray production cross sections measured at the University of Washington and elsewhere. It had been initially suggested by Lamb et al. that the observed lines were the blue- and red-shifted components of the 1.369-MeV line from the $^{24}Mg(p,p')^{24}Mg$ reaction between ^{24}Mg nuclei in the jet of SS433, moving at a speed equivalent to 33 MeV per nucleon, and ambient protons. However, this explanation implied that the shifted components of the doublet at 1.64 MeV from the $^{24}Mg(p,p\alpha)^{20}Ne$ and $^{24}Mg(p,2p)^{23}Na$ reactions should be seen with nearly the same intensity. The apparent absence of these lines argued against the original simple interpretation. It has been subsequently proposed by Ramaty, Kozlovsky, and Lingenfelter that the 1.369-MeV line could be produced by a combination of the $^{24}Mg(p,p')^{24}Mg$ and $^{28}Si(p,p\alpha)^{24}Mg$ reactions taking place in collisions between grains in the jet and ambient protons. A test of the model of Ramaty et al. can in principle be provided by further examination of the gamma-ray spectra from SS433.

32913 (DOE/ER/40048—102-L4, pp 3) **Equilibration of ^{176}Lu/sup g,m/ under stellar conditions.** Bertram, T.; Gil, S.; Kellogg, S.E.; Norman, E.B.; Wong, P. Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

As discussed in previous Annual Reports, the authors are studying processes that can occur in stellar environments by which ^{176}Lu/sup g/ and ^{176}Lu/sup m/ could come into thermal equilibrium. From observation of the photoactivation of ^{176}Lu/sup g/ - ^{176}Lu/sup m/ using a large ^{60}Co γ-ray source, the authors have found that in environments in which the temperature is $\geq 4 \times 10^8$ °K photoexcitation alone guarantees thermal equilibrium. By including the effects of positron-annihilation-excitation they find that even at the canonical s-process temperature of 3.5×10^8 °K ^{176}Lu/sup g,m/ are in equilibrium. Thus ^{176}Lu is probably not a reliable cosmochronometer but instead may be useful as a stellar thermometer.

32914 (DOE/ER/40048—102-L4, pp 3-4) **Nucleosynthesis of ^{180}Ta/sup m/.** Kellogg, S.E.; Norman, E.B. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Interest in the nucleosynthetic mechanism responsible for the production of the naturally occurring isomer, ^{180}Ta/sup m/ continues unabated. Beer and Ward suggested that ^{180}Ta/sup m/ may in fact be produced in stars by the standard s and/or r neutron capture processes through the fractional β decay f/sub β/, of 5.5 hr ^{180}Hf/sup m/ directly to ^{180}Ta/sup m/. As described in last year's Annual Report, the authors have been using a VETO technique to suppress the dominant and rich spectrum of conversion electrons which masks the 204 keV endpoint β continuum. They successfully suppressed contaminant β decays from ^{181}Hf by introducing a 50 usec software delay in the MBD code to allow an 18 usec level in ^{181}Ta to γ decay and be eligible for vetoing. Our new limit, f/sub β/ $\leq$ 0.6%, implies that the s process alone is insufficient by a factor of 5 in explaining the observed ^{180}Ta/sup m/ abundance. The authors also searched for β decays to excited states above the long-lived isomer be replacing their e^- detector with a high resolution GeLi detector and looking for single γ events in the VETO arrangement.

32915 **(FNAL/Pub—86/51-A) No hair theorem for inhomogeneous cosmologies.** Jensen, L.G.; Stein-Schabes, J.A. (Fermi National Accelerator Lab., Batavia, IL (USA)). Mar 1986. Contract AC02-76CH03000. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86009991.

We show that under very general conditions any inhomogeneous cosmological model with a positive cosmological constant, that can be described in a synchronous reference system will tend asymptotically in time towards the de Sitter solution. This is shown to be relevant in the context of inflationary models as it makes inflation very weakly dependent on initial conditions. 8 refs.

32916 **(FRNC-TH—2130) Study of emission process in hot, optically thin plasma: application to solar active regions.** Steenman-Clark, L. (Nice Univ., 06 (France)). Jun 1983. 234p. (In French). NTIS (US Sales Only), PC A11/MF A01. File Number DE86751792.

Analysis of soft X-ray got in hot and weak density plasmas, such as those in TOKAMAKS and in solar flares, needs a detailed knowledge of emission processes. In this work are presented spectroscopic diagnostics which can be deduced from such spectra analysis and results are applied to magnesium solar spectrum analysis. An important improvement is brought to collisional calculation corresponding to forbidden line populating. For this line, The relative importance of autoionizing states effect, called also resonance effect is studied.

32917 **(LA—10669-MS) Existence of undiscovered Uranian satellites.** Boice, D.C. (Los Alamos National Lab., NM (USA)). Apr 1986. Contract W-7405-ENG-36. 9p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86008161.

Structure in the Uranian ring system as observed in recent occultations may contain indirect evidence for the existence of undiscovered satellites. Using the Alfven and Arrhenius (1975, 1976) scenario for the formation of planetary systems, the orbital radii of up to nine hypothetical satellites interior to Miranda are computed. These calculations should provide interesting comparisons when the results from the Voyager 2 encounter with Uranus are made public. 15 refs., 1 fig., 1 tab.

32918 (NASA-CP—2376-VOL-2, pp vp) **Implications of new measurements of O-16 + p + C-12,13, N-14,15 for the abundances of C, N isotopes at the cosmic ray source.** Guzik, T.G.; Wefel, J.P.; Crawford, H.J.; Greiner, D.E.; Lindstrom, P.J.; Schimmerling, W.; Symons, T.J.M. (California Univ., Berkeley; Lawrence Berkeley Lab., CA). Aug 1985. NTIS, PC A19/MF A01.

In Ninteenth International Cosmic Ray Conference. OG sessions, volume 2.

The fragmentation of a 225 MeV/n O-16 beam was investigated at the Bevalac. Preliminary cross sections for mass = 13, 14, 15 fragments are used to constrain the nuclear excitation functions employed in galactic propagation calculations. Comparison to cosmic ray isotonic data at low energies shows that in the cosmic ray source C-13/C approximately 2% and N-14/0=3-6%. No source abundance of N-15 is required with the current experimental results.

32919 **(NORDITA—84/34-Prepr.) Solar oscillations.** Christensen-Dalsgaard, J. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). 1984. 54p. (CONF-840779—3-Prepr.). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751767.

From 25. Liege international astrophysical colloquium; Leige, Belgium (10 Jul 1984).

Amongst all stars observed to pulsate, the Sun has by far the largest number and variety of modes of oscillation. This presents a unique opportunity to apply and test stellar oscillation theory. To match the observational accuracy, very precise calculations of oscillation frequencies are needed. Asymptotic methods have proved useful in the analysis and interpretation of the frequencies. The results provide tight constraints on solar models; they may also enable a direct determination of properties of the solar interior. There are difficulties in reconciling the amplitudes obtained in Doppler velocity with those observed in the apparent position of the solar limb. The excitation of the oscillations is so far not well understood, although it is probable that the interaction between pulsation and convection plays an important role. (orig.).

32920 **(NORDITA—84/36-Prepr.) Physical processes in relativistic plasmas.** Svensson, R. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). 1984. 13p. (CONF-840796—3-Prep.). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751762.

From X-Ray and UV emission from active galactic nuclei conference; Carching, F.R. Germany (9 Jul 1984).

The continuum emission in many active galactic nuclei (AGNs) extend to 100 keV and beyond (e.g. Rothschild et al. 1983). In thermal models of the continuum emission this implies temperatures above 10^9 K or kT of order mc^2. In such a plasma the electrons are at least mildly relativistic and furthermore the particles and the photons are energetic enough to produce electron-positron pairs. The physics of such hot plasmas has only recently been studied in any detail and here we review the results of those studies. Significant electron-positron pair production may also occur in non-thermal models of the continuum emission if the optical depth to photon-photon pair production is greater than unity. We review the few results obtained regarding this interesting but not very well studied possibility. First, however, we briefly discuss the processes taking place in relativistic plasmas and the standard models for the continuum emission from AGNs. We then summarize the effects pair production have on these models and the observational implications of the presence of electron-positron pairs. (orig./WL).

32921 **(NORDITA—84/37-Prepr.) Ionisation of the primeval plasma at the time of recombination.** Jones, B.J.T.; Wyse, R.F.G. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). Sep 1984. 40p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751763.

We rederive the equations for the ionisation of the cosmic plasma during the recombination period, correcting some of the earlier work and refining some approximations inherent in those treatments and allow for the possibility that the universe may contain substantial amounts of non-baryonic matter (the cosmic density parameter Ωsub(T) may be greater than the baryonic contribution Ωsub(B)). The results are tabulated for various Ωsub(T)h^2 and Ωsub(B)h^2 and an assumed present day radiation temperature T_0=2.7 K. (orig./WL).

32922 (RAL—85-086, pp 52-59) **Near-infrared spectroscopy of galaxies.** Wright, G.S.; Joseph, R.D.; Wade, R.; Graham, J.R.; Gatley, I. May 1985. NTIS (US Sales Only), PC A09/MF A01. File Number DE86701774. (CONF-8505251—).

From 4. Rutherford Appleton Laboratory workshop on astronomy and astrophysics; Abingdon, UK (20 May 1985).

The paper concerns the spectra of 8 interacting galaxies and NGC253, obtained with a near infrared spectrometer. The dominant spectral features in the data include the H_2 lines (especially v=1-0 S(1), and upsilon=1-0 Q (blended 1-7)), Brackett γ, and the a^4 Fsub(7/2)-a^4 Dsub(9/2) 1.644 μm forbidden line of Fe II. These results and their implications are discussed.

32923 **Neutrino diffusion in stellar collapse.** van den Horn, L.J.; Cooperstein, J. (Department of Earth and Space Sciences, State University of New York at Stony Brook). *Astrophysical Journal;* **300**: No. 1, 142-150(1 Jan 1986). Contract AC02-80ER10719;AC02-76ER13001.

We consider the diffusion flows of neutrinos in stellar collapse. The neutrino energy and number fluxes are driven by the gradients of temperature and chemical potential, and are characterized by four Rosseland mean free paths. We derive exact expressions for these Rosseland means, taking scattering and stimulated absorption of the neutrinos into account separately as well as in combination. The Rosseland means for the combined opacities constitute new analytical results. These exact expressions represent an improvement over previously published prescriptions.

6402 Atmospheric Physics

32924 **Model for conjugate coupling from ionospheric dynamoes in the acoustic frequency range.** Jacobson, A.R. (Los Alamos National Laboratory, New Mexico). *Journal of Geophysical Research;* **91**: No. A4, 4404-4412(1 Apr 1986).

A model is developed for estimating the Pedersen currents driven in the conjugate ionosphere by an oscillatory ionospheric dynamo associated with acoustic in the upper atmosphere. The model is electrostatic within each ionosphere but uses Alfven waves in the intervening geomagnetic flux tube. The acoustic frequency range ($f \sim 10^1$—10^2 mHz) considered here allows for coupling to the geomagnetic micropulsation spectrum. Exercises of the model show that the conjugate coupling could be both efficient and observable (by HF sounding). During the daytime the preferred observational model would be of plasma compression in the upper E region. During the nighttime, only observations of F-region plasma convection would be possible. Daytime and nighttime coupling efficiencies differ markedly because of a variation in ionospheric boundary condition at the foot of the flux tube.

32925 **Motion of ions specularly reflected off a quasi-parallel shock in the presence of large-amplitude, monochromatic MHD waves.** Fuselier, S.A.; Gosling, J.T.; Thomsen, M.F. (University of California, Los Alamos National Laboratory, Los Alamos, New Mexico). *Journal of Geophysical Research;* **91**: No. A4, 4163-4170(1 Apr 1986).

A test particle model is used to study the motion of ions specularly reflected off a shock in the presence of large-amplitude, monochromatic, transverse MHD waves. The characteristics of the

motion depend on the frequency, wavelength, phase, and amplitude of the wave that is being convected into the shock. For low wave frequencies and long wavelengths ($\omega' <<$ ion gyrofrequency, $\lambda >>$ ion gyroradius), the ion motion depends only upon θ/sub B/ n(phi$_0$), the instantaneous angle between the total magnetic field at the shock (ambient+wave) and the shock normal. For high wave frequencies and short wavelengths ($\omega' >>$ion gyrofrequency, $\lambda <<$ion gyroradius), the ion motion depends only upon θ/sub B/ n_0, the angle between the ambient magnetic field and the shock normal. For intermediate frequencies and wavelengths, including those of interest in the region upstream from the earth's bow shock ($\omega' \sim$ion gyrofrequency, $\lambda \sim$ion gyroradius), no simple θ/sub B/n_0 or θ/sub B/n(phi$_0$) criterion for the ion motion is found. For example, at intermediate frequencies, the motion depends both on θ/sub B/n(phi$_0$) and θ/sub B/n_0 as well as upon b/B, the ratio of the wave amplitude to ambient magnetic field strength. In general, the presence of upstream waves inhibits the escape of specularly reflected ions from the shock, the effect being greatest when the wave amplitude is large.

32926 Highly relativistic electrons in the earth's outer magnetosphere 1. Lifetimes and temporal history 1979—1984. Baker, D.N.; Blake, J.B.; Klebesadel, R.W.; Higbie, P.R. (Los Alamos National Laboratory, University of California, Los Alamos, New Mexico). *Journal of Geophysical Research;* **91**: No. A4, 4265-4276(1 Apr 1986).

Highly relativistic electrons (3—10 MeV) at times are observed to populate the earth's magnetosphere near the geostationary orbit (r$\sim$6.6 R/sub E/). Electron fluxes and energy spectra are shown which were measured by two high-energy electron sensor systems at 6.6 R/sub E/ from 1979 to the present. Large, persistent increase in this electron population were found to be relatively infrequent and sporadic in 1979—1981 around solar maximum. This situation contrasts markedly with the frequent occurrence of very large flux increases from late 1981 to the present. Furthermore, in this latter period, which constitutes the approach to solar minimum, it is observed that the highly relativistic electrons occur with a relatively regular 27-day periodicity and are well associated with the reestablished solar wind stream structures. On the basis of an examination of long-term flux variations as a function of solar rotation we find strongly periodic behavior beginning with Bartels rotation $\sim$2035. Through a superposed epoch analysis technique we study empirical particle lifetimes as a function of particle energy. An energetic electron enhancement typically rises on a 2- to 3-day time scale and decays on a 3- to 4-day time scale at essentially all energies above $\sim$3 MeV. The present analysis suggests either that a regular pulsing by high-speed solar wind streams makes the magnetosphere an efficient relativistic electron accelerator or else that the Jovian magnetosphere is a recurrent source of a significant electron population in the outer terrestrial magnetosphere.

6403 Atomic, Molecular, And Chemical Physics

REFER ALSO TO CITATION(S) 32384, 32385, 32586, 33274, 33292

32927 (AD-A—163991/3/XAB) Atomic motion in a standing wave. Master's thesis. Scott, J.E. (Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering). Dec 1984. 66p. (AFIT/GEP/EE—84-9). NTIS, PC A04/MF A01.

The motion of an atom in an intense resonant standing laser wave is studied using the Ehrenfest-Bloch equations. Two approaches are taken to determine the radiation or light pressure force on the atom. The first, an attempt to find a Fourier series solution to the optical Bloch equations failed, but Fourier coefficient recursion formulas were found. The second, a numerical calculation of the Bloch variables and the radiation force was successful in obtaining plots of the instantaneous values. The effect of assuming constant atomic velocity is studied, and Fast Fourier Transform discrete harmonic-frequency spectra of one of the Bloch variables and the light pressure force are obtained. Finally, the Ehrenfest-Bloch equations are compared with other theories of resonant radiation pressure.

32928 (AD-A—164237/0/XAB) Relativistic gaussian basis set calculations on one-electron ions with a nucleus of finite extent. Binning, R.C. (Puerto Rico Univ., Rio Piedras). 1 Nov 1985. 5p. NTIS, PC A02/MF A01.

The disadvantages of using Gaussian functions (GTOs) in SCF electronic structure calculations are well known. The difficulties associated with Gaussians are likely to be more severe in relativistic Dirac-Fock calculations. Relativistic effects are important for core electrons, whereas GTOs give a poor description near the nucleus. By changing the boundary condition on the wavefunction at the origin, it may be possible to remove some of the difficulty. In calculations on O^{7+} and Hg^{79+}, explorer the effect of replacing the point model of the atomic nucleus by a nucleus of finite size is explored. It was found that smaller basis expansions are required for the heavier nucleus in the finite-nucleus model.

32929 (CENBG—8510) Large-angle scattering and nuclear-resonance effect in electron capture in H^+ /VC and N^+ +N collisions. Scheurer, J.N.; Baker, O.K.; Spooner, D.; Meyerhof, W.E. (Bordeaux-1 Univ., 33 - Gradignan (France). Centre d'Etudes Nucleaires). 1985. 1p. (CONF-850191—1-Summ.). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751803.

From 6. workshop on energetic atomic collisions; Oberstdorf, F.R. Germany (28 Jan 1985).

Published in summary form only.

32930 (CONF-860144—Summs.) Proceedings of the workshop on atomic physics with stored cooled heavy ion beams. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 441p. NTIS, PC A19/MF A01; 1; GPO Dep. File Number DE86010009.

From Workshop on atomic physics with stored cooled heavy ion beams; Oak Ridge, TN, USA (13 Jan 1986).

The workshop program included (1) atomic physics with stored cooled heavy ion beams, (2) ion-atom collisions and (3) electron-multicharged ion interactions. 22 papers were cataloged separately. (WRF)

32931 (DOE/ER/10676—8) Semiempirical studies of atomic structure. Progress report, 2 January 1985-1 April 1986. Curtis, L.J. (Toledo Univ., OH (USA). Dept. of Physics and Astronomy). 1986. Contract AS05-80ER10676. 4p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010295.

Brief descriptions are given for projects in the following areas: (1) screening parametric studies of alkaline earthlike ions, (2) Spectra and lifetimes of hyperalkalis and hyperalkaline earths, (3) electron self-energy corrections in highly ionized heavy atoms, and (4) measurements of lifetime and spectra of doubly excited quartet states in three electron systems. (WRF)

32932 (DOE/ER/12032—05) Photon scattering and interaction analysis of interfacial corrosion and catalysis. Technical progress report, 1 February 1982-30 January 1986. Furtak, T.E. (Rensselaer Polytechnic Inst., Troy, NY (USA)). 1986. Contract AC02-82ER12032. 10p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010579.

An overview of the research program for optical phenomena at interfaces, in thin films and in microstructures is given. Included in the discussion are surface enhanced Raman scattering (SERS) and second harmonic generation. 35 refs. (WRF)

32933 (DOE/ER/13116—8) Correlated charge changing ion-atom collisions. Progress report, March 15, 1985-March 14, 1986. Bernstein, E.M.; Tanis, J.A. (Western Michigan Univ., Kalamazoo (USA)). Apr 1986. Contract AC02-83ER13116. 22p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010390.

X-ray emission associated with projectile charge-changing events in ion-atom collisions has been used to isolate and investigate excitation, ionization, and charge transfer, as well as combinations of these processes. New measurements were made of K-shell and L-shell resonant transfer and excitation (RTE) for 210 to 300 MeV $_{20}$Ca/sup 10,11+/ + H_2 collisions and 230 to 610 MeV $_{41}Nb^{31+}$ +

H_2 collisions, respectively. Nonresonant transfer and excitation (NTE) was studied for 40 to 160 MeV S^{13+} + Ne. Single-electron capture and loss measurements, requiring accel-decel techniques, were made for 2.5 to 200 MeV S^{13+} on He. In the case of Ca/sup 16,17,18,19+/ + H_2 collisions the single capture cross cross sections exhibit a nonmonotonic energy dependence which we attribute to RTE. Double-electron capture in single collisions was investigated for S^{13+} + He and Ne and Ar^{18+} + Ne and the cross sections were found to be 10 to 100 times smaller than the single-capture cross sections. Measured two-electron loss cross sections for Ca/sup q^+/ ions incident on H_2 vary with charge state and depend strongly on whether L- or K-shell electrons are removed. Measurements of simultaneous projectile excitation and electron loss for several collision systems indicate that K-vacancy production occurs primarily through excitation rather than loss of the 1s electron. 13 refs.

32934 (FRNC-TH—2102) Monokinetic electron backscattering from amorphous or polycrystalline specimens. Ahmed, H.E.D.H. (Toulouse-3 Univ., 31 (France)). Jun 1983. 155p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE86751785.

We have considered the interaction of electrons with thin amorphous specimens: one part of these electrons is transmitted through the substance, the other being backscattered. This last phenomena, which is not perfectly understood, has been studied in the energy range from 0.3 to 3 MeV. First this work deals with the realization of a fully automatic apparatus which has been adapted to the column of the 3 MeV electron microscope of the HVFM laboratory in Toulouse. The variation of the transmission and backscattering coefficients, for amorphous and polycrystalline specimens, is determined. From this coefficient the electron range in this substance can be deduced. In addition the experimental results can be used to understand the image contrast in scanning electron microscopy. A short presentation of the cross-section, introduces the theoretical study of Monte-Carlo calculation. The Monte-Carlo calculation is used to take into account all elementary processus, which take place during electron scattering.

32935 (FRNC-TH—2117) Study of a high and low pressure plasma produced in a He-N_2 mixture: application to spontaneous emissions by radiative collisions. Marcum, S.D. (Paris-11 Univ., 91 - Orsay (France)). 1983. 160p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE86751791.

This thesis is centered on the study of the energy transfer from helium metastable atoms to ground state nitrogen molecules by the process of radiative collisions. Experimental techniques employed include the analysis of spontaneous emission from the reaction: $He(2^3S)+N_2(X,v=0) \rightarrow He(1^1S)+(N_2sup(R)(B,v'=4,5) \rightarrow N_2sup(R)(X,v'')+h\omega)$, where R indicates highly excited nitrogen Rydberg states. As the lower level Rydberg states are autoionizing, the net effect of the radiative collision is identical that of Penning ionization where the Rydberg to states are intermediates. The results of this study lend support to the validity of a radiative collision based laser amplifier model proposed in the thesis.

32936 (FRNC-TH—2119) Energy balance for secondary plasma electrons produced by a high power electron beam propagating in gas mixture: theoretical and experimental study. Richard, A. (Grenoble-1 Univ., 38 - La Tronche (France)). 1983. 145p. (In French). NTIS (US Sales Only), PC A07/MF A01. File Number DE86751787.

Propagation in gaseous atmosphere of high power beam of relativistic electrons has important application: inertial fusion, energy transport. This thesis studies theoretically and experimentally the secondary electron gas, the crossed atmosphere being nitrogen. First, in the presence of chemical and inelastic processes, the electron transport equation is written. The multiple processes are inventoried and missing cross-sections are calculated. Ionization and excitation of nitrogen molecule are studied more in detail. Source terms for transport equations are derived. An experiment, made at CEN of Valduc with EUPHROSYNE generator, and where relativistic electron beam (1.7 MV, 40 kA) is propagating in nitrogen atmosphere at different pressures, is described. From measurements, plasma parameters are found: density, temperature, often integrated on beam radius and on pulse duration.

32937 (FRNC-TH—2121) Interaction of light ion (E approximately 1 MeV/u) with thin foil targets: study of convoy electrons in the directions of emerging ions, at similar velocities. Gladieux, A. (Paris-11 Univ., 91 - Orsay (France)). Mar 1983. 137p. (In French). NTIS (US Sales Only), PC A07/MF A01. File Number DE86751784.

This thesis is related to the experimental study of convoy electrons emerging with light ions (H^+, H_3^+, He^+ and He^{++}) from 15 $\mu g/cm^2$ aluminium targets. Ion velocities pertain to the range $4v_0$ - $8v_0$. The velocity distributions of electrons obtained with protons have two components centered on the velocity of emerging ions. The large component has properties compatible with charge exchange to the continuum theories. The narrow component behaves very differently and might be indicative of an effect taking into account the polarization wake trailing the ions inside the solide. Results obtained with H_2^+, He^+ and He^{++} ions are also presented.

32938 (IAE—3855/6) Excitation and dissociation of molecular ions by electron impact. Decay of molecular Rydberg state. Lebedev, V.S.; Marchenko, V.S. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1983. 24p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701928.

Processes of excitation, dissociation and dissociative recombination of molecular ions in high vibrational states in collisions with electrons are considered. The most important, in this case, transition mechanism related to the interaction of external electron and dipole moment of molecular ion is taken account of. Inner electrons of molecular ion don't participate in the transitions considered. It is shown that for weak coupled external electron such mechanism of electron energy exchange and nuclei movement results in the appearance of the effective process of autodissociation decay of the Rydberg states of a vibration-excited molecule.

32939 (IAE—3936/6) Quadrupolar transitions induced proton impacts for multicharged ions with small excitation energy. Bazylev, V.A.; Kereselidze, T.M.; Chibisov, M.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701929.

3Dsub(3/2) reversible 3Dsub(5/2) transition cross-sections of Mosup(23+) potassium-like ion induced with proton impacts were calculated. Perturbation theory related to the interaction of a coupled electron and impinging proton was used for the calculations. The proton is considered moving in a classical path in the Coulomb repulsion field. The transition is due to the electric quadrupole interaction. Maximum cross-section is of order of 10^{-17} cm^2. An appoximating expression is obtained for the process rate constant ($v\sigma$). The calculations show that the excitation rate of the abovementioned transitions with protons in hot plasma is somewhat higher than with electrons.

32940 (JINR—R-4-84-693) Relativistic effects in the weakly bound states of ddμ and dtμ mesic molecules. Bakalov, D.D.; Vinitskij, S.I.; Melezhik, V.S.; Men'shikov, L.I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics; Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701927.

Submitted to the journal Phys. Lett. .

The relativistic shift and the fine and hyperfine splitting of the energy levels of the weakly bound states of ddμ and dtμ mesic molecules have been calculated. These results should be taken into account in the description of the resonance type formation of ddμ and dtμ.

32941 (JINR—R-14-84-273) Yield cross section of proton induced L-shell characteristic X rays. Brazevich, Ya.; Brazevich, Eh.; Osetinskij, G.M.; Pajek, M.; Ploskonka, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics; Wyzsza Szkola Pedagogiczna, Kielce (Poland)). 1984. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701930.

Submitted to the journal J. Phys., B.

Thin targets of Sb, Te, Ho, Ta, W, Pt and Bi elements have been employed and L X-ray yields have been measured as a function of proton energy from 1.5 to 3.8 MeV. From these measurements the individual and total X-ray yield cross sections have been calculated and compared with the experimental results reported by other authors and with calculations based on plane-wave Born approximations with correction for Coulomb-deflection, relativistic and energy-loss effects resulting in the ECPSSR theory of Brandt and Lapicki.

32942 (JINR—R-14-84-571) ^{4}He induced L-shell X ray production cross sections and their ratios. Brazevich, Ya.; Brazevich, Eh.; Osetinskij, G.M.; Pajek, M.; Ploskonka, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1984. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701931.

Submitted to the journal J. Phys., B.

Using Ag, Sn, Sb, Te, Ho, Ta, W, Pt and Bi thin targets, energy dependences of X-ray production cross sections for Lsub(α)-, Lsub(β)-, Lsub(γ)-, Lsub(l)-transitions and for the whole L-shell during excitation with ^{4}He ions in the energy range 1.5-3.8 MeV have been measured. The results obtained are compared with the calculations made according to the ECPSSR theory, which describes Coulomb ionization in the PWBA approximation taking into account corrections for the change in binding energy, shell polarization and relativistic effect for electrons of target atoms. Effect of deviation in Coulomb field and energy loss in incident ion during its collision with target atom is considered.

32943 (LA-UR—86-634) Measurements of laser generated impulse. King, T.; Barrus, D.; Dingus, R.; Osborne, Z.; Phipps, C. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 8p. (CONF-860616—10). NTIS, PC A02/MF A01; GPO Dep. File Number DE86007378.

From International symposium on intense dynamic loading and its effects; Beijing, China (3 Jun 1986).

The total impulse delivered by pulsed-laser illumination of planar targets in vacuum. Data are presented for several target materials (aluminum and some of its alloys, titanium, and kevlar/epoxy structural composite) as a function of incident fluence for laser wavelengths of 248 nm, 2.8 μm, and 10.6 μm. 4 tabs.

32944 (LP—202) Study of a microwave discharge in argon/helium mixtures. Saada, S.; Bloyet, E.; Dervisevic, C.; Laporte, C. (Paris-11 Univ., 91 - Orsay (France). Lab. de Physique des Plasmas). Nov 1983. 100p. (In French). NTIS (US Sales Only), PC A05/MF A01. File Number DE86751786.

A discharge created by a surface wave in argon-helium mixture is studied. First, the helium influence on plasma parameters has been studied (electron density, electric field, effective collision frequency, etc...), then, on excitation processes in the discharge. Relations between plasma lines, electron density and electric field have been established.

32945 3s—3p laser gain and x-ray line ratios for the carbon isoelectronic sequence. Feldman, U.; Seely, J.F.; Doschek, G.A.; Bhatia, A.K. (E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375—5000). *Journal of Applied Physics;* **59**: No. 12, 3953-3957(15 Jun 1986).

The populations of the 46 levels belonging to the configurations $2s^22p^2$, $2s2p^3$, $2p^4$, $2s^22p3s$, $2s^22p3p$, and $2s^22p3d$ have been calculated for ions in the C I isoelectronic sequence with atomic numbers Z = 18, 22, 26, 30, 34, and 36 and for electron densities from 10^{15} to 10^{22} cm^{-3}. The populations of the $2s^22p3p$ levels are relatively large owing to the large electron collisional monopole excitation rates from the ground configuration and to the small radiative decay rates to the ground configuration. This results in population inversions for transitions of the type 3s—3p. The gain coefficients for these transitions are determined and are compared to previous calculations. At high electron densities where collisional mixing of the excited levels becomes important, the intensities of the x-ray transitions from the $2s^22p3p$ levels to the $2s2p^3$ levels decrease relative to the x-ray transitions from the $2s^22p3s$ and $2s^22p3d$ levels. The density dependence of these x-ray line ratios is also presented. These line ratios represent a promising diagnostic for electron density.

32946 UV laser excited fluorescence spectroscopy of the jet-cooled copper dimer. Rohlfing, E.A.; Valentini, J.J. (Chemistry Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Chemical Physics;* **84**: No. 12, 6560-6566(15 Jun 1986).

UV laser excited fluorescence spectra of the jet-cooled copper dimer are reported. Cu_2 is produced via laser vaporization of the metal inside the throat of a pulsed, supersonic nozzle. Strong fluorescence is observed upon excitation of $^{63}Cu_2$ in the range 287—324 nm, corresponding to several v" = 0 bands of the II—X transition recently found in excitation using resonant two-photon ionization [Smalley et al., J. Chem. Phys. 78, 2866 (1983)]. The II—X emission spectra are characterized by extremely long progressions in the ground state vibration, enabling us to measure G(v) and ΔG/sub v/+1/2 values over the range v = 0—72. This data has been fit to yield improved vibrational constants for $^{63}Cu_2$ X $^1\Sigma^+$/sub g/: ω/sub e/ = 266.43 +- 0.59 cm^{-1}, ω/sub e/x/sub e/ = 1.035 +- 0.030 cm^{-1}, ω/sub e/y/sub e/ = +(1.70 +- 0.58) x 10^{-3} cm^{-1}, and ω/sub e/z/sub e/ = -(1.78 +- 0.37) x 10^{-5} cm^{-1}. The G(v) data has also been fit to a near-dissociation expansion which incorporates the correct limiting behavior of G(v), determined by the asymptotic inverse power contribution to the potential. This fit gives an improved dissociation energy for the dimer, and the vibrational index at dissociation: D/sub e/ = 16 760 +- 200 cm^{-1} and v/sub D/ = 128 +- 5.

32947 Theory of initial yields of ions generated by electrons in binary mixtures. Eggarter, E. (Argonne National Laboratory, Argonne, Illinois 60439). *Journal of Chemical Physics;* **84**: No. 11, 6123-6128(1 Jun 1986). Contract W-31-109-ENG-38.

Interactions of charged particles with matter concerns most often mixtures or chemically impure substances. This paper presents the first rigorous treatment of the ionization yields in a binary mixture of gases A and B in the absence of energy transfer between molecules. The Fowler equation was used, and as a first example the system Ar—H_2 was studied. Results for the number of all ions N and for the number of ions of types A or B are presented for incident electron energies T up to 2000 eV. The calculations cover the complete range of the mixture composition. Comparison with available experimental data shows excellent agreement. The mean numbers of Ar and H_2 ions present a very interesting dependence on the concentration of the species; their ratio is approximately proportional to the ratio of their partial concentrations.

32948 Metal vapor vacuum arc ion source. Brown, I.G.; Galvin, J.E.; Gavin, B.F.; MacGill, R.A. (University of California, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Review of Scientific Instruments;* **57**: No. 6, 1069-1084(Jun 1986). Contract AC03-76SF00098.

A high-current ion source is described in which a metal vapor vacuum arc is used to create the plasma from which the ion beam is extracted. An ion beam current of up to about 1 A has been measured at an extraction voltage of 25 kV for a range of metallic species spanning the periodic table from lithium to uranium. Multiply ionized charge states are seen up to as high as Q = 6+ in the case of uranium. In the metal vapor vacuum arc, regions of intense current concentration are formed at the cathode, and it is at these regions, the cathode spots, that the cathode material is vaporized and ionized to form a dense, quasi-neutral plasma which plumes away from the cathode surface. The plasma plume is caused to impinge upon a set of extractor grids, and the ion beam is extracted from the streaming metal plasma. A preliminary survey of the performance of the source has been made. We describe here the

principle of operation of the source, the source design, and the results of those measurements that we have made to date.

32949 **Electron—gas plus damped-dispersion calculation of the N_2—N_2 interaction.** LeSar, R.; Shaw, M.S. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Chemical Physics;* **84**: No. 10, 5479-5485(15 May 1986).

We present the results of a calculation of the N_2—N_2 intermolecular potential using the modified Gordon—Kim (electron—gas) model with damped-dispersion terms (MGKD potential). The calculated potential agrees well in the well region with other proposed potentials. An analytical form that fits the potential with an average error of 0.2% from the well region to 30 kK on the repulsive wall is given. Solid-state properties, such as the 0 K phase diagram and the pressure—volume curve, are calculated and are in good agreement with experiment. As a test of the repulsive region, the shock Hugoniot calculated with this potential is compared with experiment and also shows good agreement.

32950 **Coupled-channel study of rotational excitation of an electronically excited diatomic molecule by atom impact: He(^{1}S)+H_2 (B $^1\Sigma^+$/sub u/).** Grimes, R.M.; Lester W.A. Jr.; Dupuis, M. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Journal of Chemical Physics;* **84**: No. 10, 5437-5443(15 May 1986). Contract AC03-76SF00098.

Rotational energy transfer cross sections have been computed in the rigid rotor model, for the energy range 0.015—0.150 eV, using an analytic fit to ab initio interaction energies determined by others and the authors with large basis set CI approaches. Long-range interactions are described by a multipole expansion. The potential energy surface is highly anisotropic and leads to integral inelastic cross sections, typically larger than those involving ground state systems, in fair agreement with results obtained using a previously determined fit.

32951 **Reactive scattering of Na(3 ^{2}P$_3$/sub //$_2$)+HCl.** Vernon, M.F.; Schmidt, H.; Weiss, P.S.; Covinsky, M.H.; Lee, Y.T. (Materials and Molecular Research Division, Lawrence Berkeley Laboratory and Department of Chemistry, University of California, Berkeley, California 94720). *Journal of Chemical Physics;* **84**: No. 10, 5580-5588(15 May 1986).

The reaction of electronically excited Na(3P) atoms with HCl has been studied in a crossed molecular beams experiment. At collision energies slightly above the endoergicity of the reaction, Na(3P) shows a dramatic enhancement of reactivity over ground state Na(3S). Detailed measurements of the laboratory angular and velocity distributions of the reactively scattered NaCl product at 5.4 kcal/mol collision energy have allowed determination of the product center-of-mass translational and angular distributions. These experimental results are compared to the DIPR model of electron transfer reactions. The broad translational energy distribution is in qualitative agreement with the DIPR model, but the angular distribution exhibits reduced intensity for scattering perpendicular to the relative velocity vector which cannot be reproduced by the DIPR model. The preferred transition state configuration, Na—Cl—H, is consistent with what would be predicted by a diffuse 3P orbital where the Na atom appears ion-like. This configuration is opposite to that given by the dominant term in the long range multipolar expansion of the neutral reactant potential.

32952 **Vacuum ultraviolet oscillator strengths of Hg measured by sum-frequency mixing.** Smith, A.V.; Alford, W.J. (Sandia National Laboratories, Albuquerque, New Mexico 87185). *Physical Review* [*Section*] *A: General Physics;* **33**: No. 5, 3172-3180(May 1986). Contract AC04-76DP00789.

We have measured oscillator strengths for the transitions 6 ^{1}S to (5d^{10}6s np) n /sup 1,3/P$_1$ for n = 6 to 13 and to (5d^{9}6s^{2}6p) 6p' ^{1}P for atomic Hg. Two new techniques for measuring dispersion based on nonlinear-optical sum-frequency mixing are used to achieve 10% accuracy for the stronger transitions. One method uses crossed beams in a Hg heat-pipe cell to map dispersion curves in regions of anomalous dispersion. The second method uses input beams of three separate frequencies and maps regions of normal and anomalous dispersion by tuning one of the input frequencies to the red and blue of the 6 ^{3}P$_1$ level. Because the dispersion of the refractive index near a resonance is determined over a large wavelength range, the oscillator strength of that resonance is determined independent of the strengths of other transitions.

32953 **Time-resolved optical-pumping study of hydrogen discharges.** Knize, R.J.; Cecchi, J.L. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Physical Review* [*Section*] *A: General Physics;* **33**: No. 5, 3595-3597(May 1986). Contract AC02-76CH03073.

A new technique is described which utilizes optical pumping in a time-resolved mode to study atomic hydrogen produced by a discharge. Initial measurements provide information about the equilibrium atomic-hydrogen density, its temporal evolution, and the diffusion coefficient for hydrogen atoms in molecular hydrogen.

32954 **Ac Stark splitting in multiphoton excitation of atomic hydrogen in flames: Abnormal peak asymmetry due to pressure broadening.** Lau, A.M.F. (Sandia National Laboratories, Livermore, California 94550). *Physical Review* [*Section*] *A: General Physics;* **33**: No. 5, 3602-3605(May 1986).

A theory of ac Stark (or Autler-Townes) splitting occurring in double optical resonances, one of which is a two-photon transition is developed. Both laser bandwidth and collisional broadening effects are included. Theoretical results are in excellent agreement with Goldsmith's observation of two-peaked structures in the multiphoton excitation spectra of atomic hydrogen in atmospheric-pressure flames. This is believed to be the first study demonstrating that the peak asymmetry in an ac Stark doublet can be reversed due to pressure broadening.

32955 **Distorted-wave methods for electron capture in ion-atom collisions.** Burgdoerfer, J.; Taulbjerg, K. (University of Tennessee, Knoxville, Tennessee 37996; Joint Institute for Heavy Ion Research, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review* [*Section*] *A: General Physics;* **33**: No. 5, 2959-2969(May 1986). Contract AC05-84OR21400.

Distorted-wave methods for electron capture are discussed with emphasis on the surface term in the T matrix and on the properties of the associated integral equations. The surface term is generally nonvanishing if the distorted waves are sufficiently accurate to include parts of the considered physical process. Two examples are considered in detail. If distorted waves of the strong-potential Born-approximation (SPB) type are employed the surface term supplies the first-Born-approximation part of the T matrix. The surface term is shown to vanish in the continuum-distorted-wave (CDW) method. The integral kernel is in either case free of the dangerous disconnected terms discussed by Greider and Dodd but the CDW theory is peculiar in the sense that its first-order approximation (CDW1) excludes a specific on-shell portion of the double-scattering term that is closely connected with the classical Thomas process. The latter is described by the second-order term in the CDW series. The distorted-wave Born approximation with SPB waves is shown to be free of divergences. In the limit of asymmetric collisions the DWB suggests a modification of the SPB approximation to avoid the divergence problem recently identified by Dewangan and Eichler.

32956 **Collision kernel and interatomic potential.** Ho, T.; Chu, S. (Department of Chemistry, University of Kansas, Lawrence, Kansas 66045). *Physical Review* [*Section*] *A: General Physics;* **33**: No. 5, 3067-3073(May 1986).

We present a detailed study of the influence of the form and strength of the interatomic potential on the one-dimensional elastic collision kernel W(v/sub z//sup prime/,v/sub z/), a quantity of interest in the study of the effects of velocity-changing collisions on laser spectroscopic line shapes. We find that the absolute magnitudes of collision kernels are very sensitive while normalized collision kernels are moderately sensitive to the potential form used. This indicates the importance of employing realistic interatomic potentials and reliable differential cross sections in the accurate deter-

mination of collision kernels. For the case of the Lennard-Jones (12,6) potential, we found a universal semiclassical Lennard-Jones (SCLJ) analytical model function, which is the combination of a semiclassical expression for small to medium scattering angles and a classical expression for large scattering angles, capable of providing correct average quantum-mechanical behaviors of differential cross sections for all scattering angles. This greatly facilitates the (often time-consuming) numerical evaluation of the collision kernel integrals and exhibits the correct collision kernel line profiles.

32957 **Distorted-wave calculations of dielectronic recombination as a function of electric field strength.** Griffin, D.C.; Pindzola, M.S.; Bottcher, C. (Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] A: General Physics;* **33**: No. 5, 3124-3132(May 1986). Contract AC05-84OR21400.

The effects of external electric fields on dielectronic recombination have been studied in the distorted-wave approximation. The eigenvectors for the doubly excited Rydberg states were determined by diagonalizing a Hamiltonian matrix which includes the internal electrostatic and spin-orbit terms, as well as the Stark matrix elements. Calculations were performed for the dielectronic recombination transitions associated with the 2s→2p excitation in the Li-like ions B^{2+}, C^{3+}, and O^{5+}; and the 3s→3p excitation in the Na-like ions P^{4+}, S^{5+}, and Cl^{6+}. The results for the Na-like ions are compared with recent merged-beam measurements, and the differences between the two sequences with respect to the enhancement of dielectronic recombination as a function of electric field strength are discussed.

32958 **Relativistic two-photon emission: Lifetime of the 2 $^1S_0$ state of helium-like Kr^{34+}.** Marrus, R.; Vicente, V.S.; Charles, P.; Briand, J.P.; Bosch, F.; Liesen, D.; Varga, I. (Department of Physics and Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720). *Physical Review Letters;* **56**: No. 16, 1683-1686(21 Apr 1986). Contract AC03-76SF00098.

The two-photon (2E1) decay 2 $^1S_0$-1 $^1S_0$ in the heliumlike ion Kr^{34+} has been observed and the lifetime measured. Departures are measured for the first time from the predictions of the nonrelativistic theory, and are sensitive to relativistic effects on the transition-matrix elements. The measured lifetime is tau(measured) = 34.08(0.34) x 10^{-12} s compared to tau(nonrelativistic) = 31.94(0.01) x 10^{-12} s.

32959 **Dielectronic satellite spectra for He-like ions.** Hsiung Chen, M. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Atomic Data and Nuclear Data Tables;* **34**: No. 2, 301-356(Mar 1986).

The wavelengths, radiative transition probabilities, and Auger rates have been calculated relativistically for transitions $1s2l2l'$-$1s^22l''$, $1s2l3l'$-$1s^23l''$, $1s2l2l'$-$1s^2\epsilon l''$, and $1s2l3l'$-$1s^2\epsilon l$ using the multi-configuration Dirac-Fock model. Ions with atomic number $6 < \text{or} = Z < \text{or} = 42$ have been considered. Generalized Breit interaction and quantum electrodynamic corrections are taken into account in the calculations of transition energies. Transition rates are computed in intermediate coupling with configuration interaction. The generalized Breit interaction is included in the evaluation of both mixing coefficients and relativistic Auger matrix elements. The dielectronic satellite intensity factors and line fluorescence yields are also calculated.

32960 **Method for precisely computing molecular integrals over STOs with n=l.** Suzuki, N. *Denki Tsushin Daigaku Gakuho;* **36**: No. 1, vp(Sep 1985).

Calculations of the relativistic effects in molecules by the use of the Dirac equation requires the evaluation of molecular integrals over atomic orbitals (AOs) with principal and azimuthal quantum numbers, n and l, of the same value. However, a method of precisely computing such molecular integrals has not yet been established. A method is given for precise evaluation of such diatomic molecular integrals by the use of Slater type orbitals (STOs) as AOs. Most types of those integrals can readily be evaluated by introducing an auxiliary integration function, -Ei(-alpha) where alpha is positive, into the established formulations able to calculate the diatomic molecular integrals over STOs with n=l. In evaluation of two electron two center Coulomb repulsion integrals, however, the division of the integration region into several parts is necessary because the charge density expressed by product of two n=l STOs centered at the same nucleus, varies very sharply near the nucleus.

32961 **Laser optical pumping in nuclear physics: fission isomers, oriented targets, and hyperfine pumping in single-electron atoms.** Bemis, C.E. Jr. (Oak Ridge National Lab., TN, USA). *Hyperfine Interactions;* **24**: No. 1-4, 139-142(Aug 1985). (CONF-840152—).

From International workshop on hyperfine interactions; Kanpur, India (16 Jan 1984).

Published in summary form only.

32962 **Relativistic calculation of atomic transition probabilities.** Chen, M.H. (Lawrence Livermore Lab., Livermore, CA). pp 31-96 of Atomic inner-shell physics. Crasemann, B. New York, NY; Plenum Press (1985).

This chapter reviews the theoretical calculations of atomic inner-shell transition probabilities from independent-particle models. Also explored are some factors affecting the inner-shell transition rates, with special emphasis on the effects of relativity. The effects of relativity on atomic transition probabilities can arise from several different factors such as change in energies; relativistic orbital effects caused by the inclusion of the mass-velocity correction, the Darwin term, and spin-orbit interaction in the Dirac Hamiltonian and the indirect relativistic effect, and the relativistic aspects of the pertinent operators. The net effect depends on the relative strengths and phases of these factors. The effects of relativity on the transition rates of atoms with a single inner-shell vacancy can be seen more vividly in heavy elements. General conclusions are offered concerning the effects of relativity on radiative transitions as well as radiationless transitions.

32963 **Rayleigh scattering: elastic photon scattering by bound electrons.** Kissel, L.; Pratt, R.H. (Sandia National Labs., Albuquerque, NM). pp 465-532 of Atomic inner-shell physics. Crasemann, B. New York, NY; Plenum Press (1985).

This chapter discusses "Rayleigh scattering" or the elastic scattering of photons from atomic electrons, leaving the target atom unchanged after scattering. Depending on the choice of energy and scattering angle, the process can be used as a sensitive probe of either inner-shell or outer-shell structure. The cross sections for the main elastic and inelastic photon-atom process, as a function of photon energy, are illustrated. Rayleigh scattering has commonly been estimated in a simple form-factor approximation that is described in this chapter. The physical features of elastic scattering and experimental methods for the measurement of elastic scattering in circumstances for which the dominant contribution comes from inner-shell atomic electrons are also covered. A comparison of theory and experiment is presented and Rayleigh scattering applications are described.

32964 **Dissociation of molecules by slow electrons.** Compton, R.N.; Bardsley, J.N. (Oak Ridge National Laboratory, Oak Ridge, TN). pp 275-349 of Electron-molecule collisions. Shimamura, I.; Takayanagi, K. New York, NY; Plenum Press (1984).

At a first glance it might appear unlikely that the nuclei within a molecule can be separated in a collision with such a light particle as an electron. However, according to the Born-Oppenheimer principle, the effective potential controlling the motion of the nuclei is given by the eigenvalues of the electronic Hamiltonian. Thus, a change in the electronic structure of the molecule can have a profound effect on the nuclear motion, and an electronic transition will often be accompanied by vibrational excitation or dissociation of the molecule. It is useful to divide the various dissociative processes into three groups that we will call dissociative excitation, dissociative ionization, and dissociative capture. Each of these three processes can be viewed, following the Born-Oppenheimer ideas, in terms of an electronic transition in which the nuclei do not move, followed by dissociation of the nuclei along a modified potential. In dissociative excitation the initial step involves the electronic excitation of the target molecule, either through direct or exchange scat-

tering. Dissociation will be a likely outcome if the excited state has a potential curve with a minimum at a relatively large value of R. With respect to electron-impact ionization, the removal of one of the target electrons from a stable molecule almost always leads to a more weakly bound electronic state. This is especially true if the ejection of the electron leaves the molecular ion in an excited state. For example, the excited electronic states of H^+_2 have potential curves that are either completely repulsive or have very weak attractive regions at extremely large R. Hence ionization of a molecule often leads to dissociation.

32965 **Angular spectrum of the 88% efficient Raman generator.** Carlsten, J.L.; Ball, D.P. (Physics Dept., Montana State Univ., Bozeman, MT 59717). pp 255-256 of Lasers '84. McLean, VA; STS Press (1984). (CONF-8411153—).

From International conference on lasers '84; San Francisco, CA, USA (26 Nov 1984).

Measurements of the angular spectrum of the first Stokes beam from a Raman generator confirm the predictions of a recent model of Bobbs and Warner which explains the unexpected hold off in second Stokes generation.

32966 **Coupled-channels calculations of excitation and ionization in collisions of negatively charged projectiles with atoms.** Martir, M.; Reading, J.F.; Ford, A.L.; Becker, R.L. (Texas A and M Univ., College Station, USA. Dept. of Physics; Oak Ridge National Lab., TN, USA). pp 188-189 of Physics of electronic and atomic collisions. Abstracts of contributed papers I. Datz, S. (ed.). Amsterdam, Netherlands; North-Holland (1981). (CONF-810754—).

From 12. IPEAC international conference on the physics of electronics and atomic collisions; Gatlinburg, TN, USA (15 Jul 1981).

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REFER ALSO TO CITATION(S) 33250, 33288

32967 **(AD-A—164298/2/XAB) Operational characteristics of a high voltage dense plasma focus. Final report, 7 May 1982-19 April 1985.** Woodall, D.M. (New Mexico Univ., Albuquerque (USA). Dept. of Chemical and Nuclear Engineering). Nov 1985. 160p. NTIS, PC A08/MF A01.

A high-voltage dense plasma focus powered by a single-stage Marx bank was designed, built and operated. The maximum bank parameters are: voltage--120 kV, energy--20 kJ, short-circuit current--600kA. The bank impedance is about 200 millohms. The plasma focus center electrode diameter is 1.27 cm. The outer electrode diameter is 10.16 cm. Rundown length is about 10 cm, corresponding to a bank quarter period of about 900 millohms ns. Rundown L is about 50 milliohms. The context of this work is established with a review of previous plasma focus theoretical, experimental, and computational work and related topics. Theoretical motivation for high-voltage operation is presented. The design, construction, and operation of this device are discussed in detail. Results and analysis of measurements obtained are presented. Device operation was investigated primarily at 80 kV (9 kJ), with a gas fill of about 1 torr H2, plus 3-5 percent A. The following diagnostics were used: gun voltage and current measurements; filtered, time-resolved x-ray PIN measurements of the pinch region; time-integrated x-ray pinhole photographs of the pinch region; fast-frame visible light phototgraphs of the sheath during rundown; and B probe measurements of the current sheath shortly before collapse.

32968 **(AD-A—164345/1/XAB) Investigation of the plasma properties of surface discharges. Final report, 1 October 1984-30 September 1985.** Beverly, R.E. (Beverly (R.E. III) and Associates, Columbus, OH (USA)). 30 Sep 1985. 63p. NTIS, PC A04/MF A01.

Large-area (60-220 sq cm), short-pulse (approx. 1 microsec) planar discharges employing profiled electrodes have been produced across various polymer substrates. Parametric studies of the electrical-circuit parameters and discharge dimensions demonstrate the importance of proper source driver impedance matching to short-pulse operation. The degree of spatial homogeneity depends upon the peak discharge voltage, the initial rate of voltage rise, the specific capacitance of the substrate, the gas atmosphere and pressure, and the ablation mode of the substrate. Spectroscopic studies were performed to measure the equivalent brightness temperature, electron temperature, electron density, and optical thickness of smaller-area (24 sq cm) surface discharges across perovskite ceramic substrates. Detailed measurements were conducted with the spectrometer slit image perpendicular and parallel to the substrate surface, with the latter measurements being performed at incremental heights above the surface, with the latter measurements being performed at incremental heights above the surface. The plasma is not opaque in the soft-uv and shows considerable structue due to line emission from neutral and singly-ionized species originating from the gas atmosphere and vaporized substrate material. Keywords: Surface discharges; Incoherent optical sources; Electrical properties; Breakdown time; Electrical recovery; Gasdynamic behavior; Shock waves; Optical detonation; Radiative properties; and Spectroscopy.

32969 **(ORNL—6189) Remarks on the choice of a stiff ordinary differential equation solver for the solution of fluid flow problems.** Thompson, S. (Oak Ridge National Lab., TN (USA)). Mar 1986. Contract AC05-84OR21400. 39p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010080.

Several aspects of the solution of fluid flow problems are discussed. A model problem is described which captures several of the salient characteristics of such problems. The model problem is derived from the one-dimensional Euler equations. It corresponds to the subcooled liquid region of a three region reactor steam generator model. The defining partial differential equations are discretized spatially using the method of pseudo-characteristics. The resulting system of ordinary differential equations is then solved by the method of lines using each of several available ordinary differential equation (ode) solvers. In addition to demonstrating that fluid flow problems can be solved effectively using adaptive mathematical software, the results also illustrate the typical performance of each solver as well as the relative merits of special solver features (eg., automatic method switching and exploitation of problem sparsity or bandedness). The model problem is also modified and used to illustrate several commonly observed characteristics of fluid flow models. The results illustrate the potential effect of solver performance of characteristics such as inaccurate water property calculations. Consequently, they explain apparent anomalies often attributed incorrectly to poor solver design and algorithmic implementation. The results also support the choice of the sparse ordinary differential solver LSODES for the solution of fluid flow problems. 16 refs., 29 tabs.

32970 **(UCRL—92436) Discrete particle computer methods for modeling granular flow.** Walton, O.R. (Lawrence Livermore National Lab., CA (USA)). Jan 1986. Contract W-7405-ENG-48. 11p. (CONF-860625—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86005202.

From American Society of Civil Engineers meeting on advancements in aerodynamics, fluid mechanics and hydraulics; Minneapolis, MN, USA (3 Jun 1986).

Recent adaptations of molecular-dynamics-like techniques to systems of inelastic, frictional particles are being used to probe the details of granular flow behavior. A variety of calculational approaches are beng pursued including: rigid-particle, soft-particle, suspended particle and Monte Carlo flow simulations. Much such calculational efforts have investigated only relatively simple configurations to date, such as assemblies of equal-sized circular particles restricted to motion in a single plane. Periodic boundaries are often used to allow simulation of semi-infinite systems with a relatively small number of particles. A few models have been extended to three-dimensions with inelastic, frictional spheres. Where comparisons have been possible, agreement with experiments and with some theories have been good. In many circumstances the numerical simulations are providing heretofore unavailable information on the micromechanisms occurring in deforming granular materials. These details include stress networks in quasistatic deformations, residual internal stresses in unloaded assemblies, shear layers in high density rapid shearing flows and highly anisotropic deviatoric velocity distributions and large normal stress differences in rapid

shearing flows at low solids concentrations. Various approaches and their results are briefly reviewed.

32971 **Condition for pressure isotropy.** Newcomb, W.A. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550 and Department of Applied Science, University of California, Davis, California 95616). *Physics of Fluids;* **29**: No. 6, 1854-1859(Jun 1986). Contract W-7405-ENG-48.

For a collisionless, relativistic electron fluid, conditions on the velocity field are formulated which are necessary for the maintenance of pressure isotropy in the local fluid rest frame. A complete characterization of all velocity fields which satisfy these conditions is worked out in the nonrelativistic limit, and a few simple examples are given in the relativistic case.

32972 **Vapor condensation in the presence of a noncondensable gas.** Pong, L.; Moses, G.A. (Fusion Technology Institute, 1500 Johnson Drive, University of Wisconsin—Madison, Madison, Wisconsin 53706). *Physics of Fluids;* **29**: No. 6, 1796-1804(Jun 1986).

Kinetic theory principles are used to study one-dimensional steady-state vapor condensation phenomena in the presence of a noncondensable gas. The results have been fitted to an interpolation formula describing the condensation flux that reduces to the one obtained by Labuntsov and Kryukov [Int. J. Heat Mass Transfer 22, 989 (1979)] in the limit of no noncondensable gas.

32973 **Microscopic calculations of the excitation spectrum of one ^{3}He impurity in liquid ^{4}He.** Fabrocini, A.; Fantoni, S.; Rosati, S.; Polls, A. (Department of Physics and Material Research Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Physical Review [Section] B: Condensed Matter;* **33**: No. 9, 6057-6067(1 May 1986). Contract AC02-76ER01198.

We calculate the chemical potential ϵ_0 and the effective mass $m(/m_3$ of one ^{3}He impurity in liquid ^{4}He. First a variational wave function including two- and three-particle dynamical correlations is adopted. Triplet correlations bring the computed values of ϵ_0 very close to the experimental results. The variational estimate of $m(/m_3$ includes also backflow correlations between the ^{3}He atom and the particles in the medium. Different approximations for the three-particle distribution function give almost the same values for $m(/m_3$. The variational approach underestimates $m(/m_3$ by $\sim$10% at all of the considered densities. Correlated-basis perturbation theory is then used to improve the wave function to include backflow around the particles of the medium. The perturbative series built up with one-phonon states only is summed up to infinite order and gives results very close to the variational ones. All the perturbative diagrams with two independent phonons have then been summed to compute $m(/m_3$. Their contribution depends to some extent on the form used for the three-particle distribution function. When the scaling approximation is adopted, a reasonable agreement with the experimental results is achieved.

32974 **Variational and diagrammatic evaluations of the ground-state energy of quantum liquids.** Krotscheck, E.; Smith, R.A.; Jackson, A.D. (Max-Planck-Institut fuer Kernphysik, D-6900 Heidelberg, Federal Republic of Germany). *Physical Review [Section] A: General Physics;* **33**: No. 5, 3535-3536(May 1986). Contract AC02-76ER13001.

The Feynman-Hellmann theorem shows that the exact ground-state energy of a quantum system may be obtained by integrating the potential energy with respect to a coupling constant. For approximation schemes in which the energy is actually calculated from an energy functional, we show that direct and coupling-constant integration evaluations of the energy functional are identical, provided that the energy functional is optimized.

32975 **ORMEC: A three-dimensional MHD spectral inverse equilibrium code.** Hirshman, S.P.; Hogan, J.T. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Journal of Computational Physics;* **63**: No. 2, 329-352(Apr 1986). Contract AC05-84OR21400.

The Oak Ridge Moments Equilibrium Code (ORMEC) is an efficient computer code that has been developed to calculate three-dimensional MHD equilibria using the inverse spectral method. The fixed boundary formulation, which is based on a variational principle for the spectral coefficients (moments) of the cylindrical coordinates R and Z, is described and compared with the finite difference code BETA developed by Bauer, Betancourt, and Garabedian. Calculations for Heliotron, Wendelstein VIIA, and ATF configurations are performed to establish the accuracy and mesh convergence properties for the spectral method.

6450 High Energy Physics

32976 **(INIS-SU—320) Proceedings of the 6. International seminar on high energy physics and quantum field theory. Vol. 2.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij; Moskovskij Gosudarstvennyj Univ. (USSR). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki). 1984. 375p. (In Russian). (CONF-8307163—Vol.2). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457.

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

Individual papers in these seminar proceedings are abstracted separately. (LEW)

32977 **(INIS-SU—321) Proceedings of the 7. Seminar on problems of high energy physics and quantum field theory. Vol. 1.** (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov. Inst. Fiziki Vysokikh Ehnergij). Jul 1984. 438p. (In Russian). (CONF-8407160—Vol.1). NTIS (US Sales Only), PC A19/MF A01. File Number DE86780458.

From 7. seminar on problems of high energy physics and quantum field theory; Protvino, USSR (1 Jul 1984).

Individual papers in these seminar proceedings are abstracted individually. (LEW)

32978 **(INIS-SU—324) JINR rapid communications. Collection.** (Joint Inst. for Nuclear Research, Dubna (USSR)). 1984. 27p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86780460.

Individual communications in this collection are abstracted separately. (LEW)

32979 **(INIS-SU—325) JINR rapid communications. Collection.** (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics; Gomel'skij Politekhnicheskij Inst. (Byelorussian SSR)). 1985. 56p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86780459.

Individual communications in this collection are abstracted separately. (LEW)

6451 Particle Interactions And Properties - Experimental

REFER ALSO TO CITATION(S) 32592

32980 **(BONN-HE—85-36) New results from the UA5/2-experiment.** Geich-Gimbel, C. (Bonn Univ. (Germany, F.R.). Physikalisches Inst.). Dec 1985. 12p. (CONF-8509269—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751733.

From 1. topical European meeting on quark structure of matter; Strasbourg, France (26 Sep 1985).

Preliminary results from the recent UA5/2 run at $\sqrt{s}$=200 and 900 GeV (when the CERN SPS Collider was operated in pulsed mode) are presented. Subjects covered are the determination of the cross section ratio at 200 and 900 GeV, absolute proton-antiproton cross sections and searches for unusual phenomena. (orig.).

32981 (DESY—86-002) Upper limit for two-jet production in direct Y(1S) decays. Albrecht, H.; Binder, U.; Harder, G.; Lembke-Koppitz, I.; Philipp, A.; Schmidt-Parzefall, W.; Schroeder, H.; Schulz, H.D.; Wurth, R.; Donker, J.P. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Dortmund Univ. (Germany, F.R.). Inst. fuer Physik; Heidelberg Univ. (Germany, F.R.). Inst. fuer Hochenergiephysik; McGill Univ., Montreal, Quebec (Canada); Carleton Univ., Ottawa, Ontario (Canada); Toronto Univ., Ontario (Canada)). Jan 1986. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751737.

Using the ARGUS detector at the e^+e^- storage ring DORIS II at DESY, we have studied the distribution of various topological quantities on the Y(1S) resonance and in the nearby continuum. With the help of the second Fox-Wolfram moment we determine the two-jet contribution to direct Y(1S) decays to be less than 5.3% with 95% confidence. (orig.).

32982 (DOE/ER/40036—5) Measurement of observables in the pion-nucleon system and investigation of charge symmetry in ^{3}He and ^{3}H. Progress report, March 1, 1985-February 28, 1986. Sadler, M.E. (Abilene Christian Univ., TX (USA)). Mar 1986. Contract AS05-81ER40036. 78p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010294.

Progress is reported for the past year in pion scattering programs. The measurements include: (1) a complete set of observables in the pion-nucleon system in the momentum interval 400 to 700 MeV/c, (2) differential cross sections at low energy for pion-nucleon charge exchange, and (3) elastic and inelastic scattering of π^{+-} on ^{3}H and ^{3}He. The experiments are conducted at the Clinton P. Anderson Meson Physics Facility at Los Alamos (LAMPF).

32983 (FNAL-TM—1396) Hadroduction of heavy flavors. Leedom, I.D. (Fermi National Accelerator Lab., Batavia, IL (USA)). Apr 1986. Contract AC02-76CH03000. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010595.

The current state of knowledge of heavy quark production, particularly charm, by hadron beams is reviewed. The state of knowledge of total cross section, p/sub T/ and x/sub F/ dependence of charm hadroproduction is given. Besides D production, production of D^* is discussed. Also covered is the present evidence for hadronically produced B mesons. 28 refs., 5 figs., 3 tabs. (LEW)

32984 (HD-PY—86/01) Search for new particles in e^+e^- annihilation. Komamiya, Sachio. (Heidelberg Univ. (Germany, F.R.). Physikalisches Inst.). 1986. 47p. (CONF-850819—15). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751759.

From 12. international symposium on lepton and photon interactions at high energies; Kyoto, Japan (19 Aug 1985).

Recent experimental results for new particle searches in e^+e^- annihilation have been reviewed. Results are from PETRA (CELLO, JADE, MARK-J, PLUTO, TASSO), PEP (ASP, HRS, MAC, MARK-II, PEP-14, TPC), CESR (CLEO, CUSB), DORIS-II (ARGUS, CRYSTAL BALL). The topics covered are the following: (I) Particles expected in the (extended) standard model. (I.1) Quarks (top, fourth generation, free quarks). (I.2) Leptons (fourth generation charged and neutral leptons). (I.3) Higgs (minimal Higgs, non-minimal neutral and charged Higgs). (II) Supersymmetry. (II.1) Partner of matter fermions (e, q tilde). (II.2) Gauginos (W tilde, H, g tilde, unstable γ tilde). (III) Compositeness. (III.1) Excited leptons (esup(*), μsup(*), tausup(*)). (III.2) Coloured leptons (e_8, μ_8, ν_8). (III.3) Preon mass scale (contact interaction). (orig./HSI).

32985 (INIS-mf—9874) Experiments at CERN in 1985. (European Organization for Nuclear Research, Geneva (Switzerland)). Nov 1985. 300p. NTIS (US Sales Only), PC A13/MF A01. File Number DE86701967.

This book is a compilation of the current experimental program at CERN. The experiments listed are being performed at one of the following machines: the Super Proton Synchrotron (SPS), the Proton Synchrotron (PS) and the Synchro-Cyclotron (SC). The four experiments to be done by means of the Large Electron Positron machine (LEP) are also listed. The schematic layouts of beams and experiments at the various machines are given in the beginning of the report. The experiment goals and methods are briefly described and a schematic layout of the apparatus is included. Lists of participants and their institutions are also given. The status of the experiments (preparation, data-taking, completed) corresponds to the situation as of 1st November, 1985. "Completed" means only that data-taking is finished, not necessarily the analysis of the results; this status is kept for two years and then the experiment is removed from the catalogue. A complete list of all experiments published in this book since 1975 is given at the end of the catalogue.

32986 (ITEF—24(1984)) Angular distribution of p, d and π from the π^- (5 GeV/c) + A(C, Pb) → a(p,d,π) + X reaction near 180 deg in l.s. . Vorob'ev, L.S.; Gavrilov, V.B.; Goryainov, N.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 20p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701968.

Angular distribution in the range of the largest angles of secondary particle escape has been studied in detail. Data on the secondary p, d, π produced on C and Pb nuclei induced by π^- mesons of 5 GeV/c momentum are given. Irregularities in the angular distribution near 180 deg l.s. have been found. It is noted that no model exists within the framework of which the results obtained can be now decribed.

32987 (JINR—E-1-84-263) Quark (diquark) fragmentation in soft πpp interactions at P=40 GeV/c. Didenko, L.A.; Grishin, V.G.; Kuznetsov, V.A.; Metreveli, Z.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy; Tbilisskij Gosudarstvennyj Univ. (USSR)). 1984. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701969.

Submitted to the All-union seminar Quarks-84 and to the 22. International conference on high energy physics.

The quark and diquark fragmentation into π^{+-}-, K°-mesons and Λ-hyperons in soft π^-p-interactions at 40 GeV/c is studied. Fragmentation Dsup(πsup(+-)) (Xsub(F)) and invariant Fsup(πsup(+-)) (Xsub(F)) functions are compared with analogous data on ν(anti ν)p - interactions. It is shown that a good agreement exists in the region Xsub(F) > or approximately 0.15 for these different processes. The Xsub(E)-dependence of the quark and diquark fragmentation function for neutral kaons is similar to that in e^+e^- annihilation. The pickup probability of strange s(anti s) quark (lambda sub(s)) and diquark (lambda sub(qq)) relative to u(anti u) and d(anti d) quarks from the sea has been found to be equal to lambda sub(s)=0.17 and lambda sub(qq)=0.14 +- 0.03.

32988 (JINR—R-1-85-184) Measurement of total cross sections of rho°-meson interaction with intranuclear nucleons in π^-C interactions at 5 GeV/c. Abdinov, O.B.; Bajramov, A.A.; Bogush, A.A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems; AN Belorusskoj SSR, Minsk. Inst. Fiziki). 1985. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701970.

Submitted to the journal Sov. J. Nucl. Phys. .

Processes of incoherent production of rhosup(n) -mesons in πsup(-)C interactions have been investigated at 5 GeV/c, and the results are presented. Total cross sectons for interactions between intranuclear nucleons and non-polarized σ(rhosup(n) N)=25sub(-9)sup(+11) mb and longitudinally polarised σsub(L)(rhosup(0) N)=23sub(-11)sup(+14) mb rhosup(0) -mesons have been measured. The analysis of the data on the total cross section for rhosup(0) N-interactions in the (2.6-6.8) GeV interval shows that this cross section is independent of the helicity value of rhosup(0) -mesons.

32989 (KFK—4035) Search for new particles in e^+e^- annihilation. Fluegge, G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Kernphysik). Jan 1986. 45p. (CONF-8508139—2). NTIS (US Sales Only), PC A03/MF A01. File Number DE86901358.

From 10. Hawaii topical conference in particle physics; Honolulu, Hawaii (26 Aug 1985).

Recent results on search for new particles in e^+e^- annihilation are presented. Search for new elementary fermions, Higgs particles, supersymmetric particles, and indications of compositeness all turn out to be negative and yield limits on particle masses. Some puzzling phenomena are discussed.

32990 **Decay $D^0 \rightarrow phiK^0$.** Bebek, C.; Berkelman, K.; Blucher, E.; Cassel, D.G.; Copie, T.; DeSalvo, R.; DeWire, J.W.; Ehrlich, R.; Galik, R.S.; Gilchriese, M.G.D. (Cornell University, Ithaca, New York 14853). *Physical Review Letters;* **56**: No. 18, 1893-1896(5 May 1986).

We have observed a signal for the decay $D^0 \rightarrow phiK^0$. We find that a broad threshold enhancement in the K^+K^- mass spectrum in the decay $D^0 \rightarrow K^+K^-K^0$ is the main source of background to the $D^0 \rightarrow phiK^0$ signal. Accounting for this background, we obtain the branching fraction $B(D^0 \rightarrow phiK^0) = (1.18 +- 0.40 +- 0.17)\%$.

32991 **Study of polarized proton diffraction dissociation in the reaction p/sub arrow-up/p$\rightarrow$p$\pi^+\pi^-$p at 11.75 GeV/c.** Finley, J.P.; Wicklund, A.B.; Arenton, M.W.; Ayres, D.S.; Diebold, R.; Kramer, S.L.; May, E.N.; Nodulman, L.J.; Sauer, J.R. (Argonne National Laboratory, 9700 So. Cass Ave., Argonne, Illinois 60439). *Physical Review [Section] D: Particles and Fields;* **33**: No. 9, 2528-2562(1 May 1986). Contract W-31-109-ENG-38.

We present angular distributions and, for the first time, single-spin correlations in the diffraction-dissociation reaction p/sub arrow-up/p$\rightarrow$p$\pi^+\pi^-$p, for small momentum transfers between the polarized beam and the ($p\pi^+\pi^-$) system, at 11.75 GeV/c. The only structures seen in our 2 x 10^6-event sample turn out to be the well-known threshold enhancement in $\Delta\pi$ and the N(1700), which appears to involve both $\Delta\pi$ and N(1520)π. The production process exhibits a slope-mass correlation and patterns of helicity nonconservation seen in higher-energy diffractive processes. We also see evidence for a complex helicity structure in the spin correlations. We show that the threshold enhancement is unambiguously S wave in character, while the N(1700) appears to be a mix of states. The overall similarities between our data and those at higher energies, together with the rich structures contained in the angular-distribution correlations (we measure 315 joint moments in each mass and t bin), make our data base highly relevant for theoretical analysis of exclusive diffraction.

32992 **Observation of a narrow enhancement in phiKK and phi$\pi\pi$ final states produced in 400-GeV p-N interactions.** Green, D.R.; Fenker, H.C.; Lai, K.W.; LeBritton, J.; Lin, Y.C.; Pifer, A.E.; Davenport, T.F.; Goldman, J.H.; Hagopian, S.L.; Lannutti, J.E. (Fermilab, Batavia, Illinois 60510). *Physical Review Letters;* **56**: No. 16, 1639-1642(21 Apr 1986).

We observe a narrow enhancement in phiK^+K^- and phi$\pi^+\pi^-$ final states, with a mass of 2.141 +- 0.012 +- 0.010 GeV/c^2 and width of 0.049 +- 0.028 GeV/c^2. The relative branching ratio is $B(M \rightarrow phiK^+K^-)/B(M \rightarrow phi\pi^+\pi^-) = 0.49$ +- 0.16, inconsistent with M being a qq-bar state.

32993 **Λ production in e^+e^- annihilations at 29 GeV: comparison with Lund-model predictions.** Baringer, P.; Abachi, S.; Akerlof, C.; Beltrami, I.; Blockus, D.; Bonvicini, G.; Brabson, B.; Brom, J.M.; Bylsma, B.G.; Chapman, J. (Argonne National Laboratory, Argonne, Illinois 60439; Indiana University, Bloomington, Indiana 47405; Lawrence Berkeley Laboratory, Berkeley, California 94720; University of Michigan, Ann Arbor, Michigan 48109; Purdue University, West Lafayette, Indiana 47907). *Physical Review Letters;* **56**: No. 13, 1346-1349(31 Mar 1986). Contract W-31-109-ENG-38;AC02-76ER01112;AC03-76SF00098;AC02-76ER01428.

This paper presents measurements of the inclusive production cross sections of Λ baryons in e^+e^- annihilations at $\sqrt{s} = 29$ GeV. The data sample corresponds to an integrated luminosity of 256 pb^{-1} collected with the High-Resolution Spectrometer at the SLAC storage ring PEP. Comparisons are made to the predictions of the Lund model. The data are well described with use of a strange diquark suppression parameter, (us/ud)/(s/d), of 0.89 +- 0.10/sub -0.16//sup +0.56/, and the measured Λ/sub c/$\rightarrow\Lambda$+X branching ratio of (23 +- 10%).

32994 **Recent progress in understanding trinucleon properties.** Friar, J.L.; Gibson, B.F.; Payne, G.L. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, NM). *Annual Review of Nuclear and Particle Sciences;* **34**: 403-433(1984).

The traditional approach of nuclear physics describes nuclei by means of a model in which nonrelativistic nucleons interact via two-body or pair-wise forces. In this brief review we concentrate entirely on the three- and four-nucleon systems, with emphasis on three-nucleon calculations using realistic forces. We focus our discussion on advances in three topics that have preoccupied researchers recently: meson-exchange currents and the trinucleon charge and magnetic densities and form factors; three-nucleon forces and their effect on observables, and the effect of the nucleon-nucleon tensor force on observables. Clearly, a comprehensive study of any of these topics is beyond our resources. Fortunately, several related themes recur and unite these disparate topics, and we concentrate on these.

32995 **Improved b lifetime measurement from MAC.** Ford, W.T. (Univ. of Colorado, Boulder, CO). pp 77-90 of Flavor mixing in weak interactions. Vol. 20. Chau, L.L. New York, NY; Plenum Press (1984). (CONF-8403113—).

From Europhysics conference; Erice, Italy (4 Mar 1984).

Two recent publications, from the MAC and Mark II collaborations, have reported the somewhat surprising result that the lifetime of particles made up of b quarks is in the 1 to 2 picosecond range, or somewhat longer than the lifetimes of charm particles. Although the charm decays are favored transitions while those of b particles depend upon off-diagonal elements of the weak flavor mixing matrix, the smallness of the b decay rates in face of the large available phase space indicates that the off-diagonal elements are indeed very small. The possibility for complete determination of the mixing matrix was brought significantly nearer by the availability of the lifetime information; what is needed now is to reduce the uncertainty of the measurements, which was about 33% for both experiments. We describe here an extension of the b lifetime study with the MAC detector, incorporating some new data and improvements in the analysis.

6452 Particle Interactions And Properties - Theoretical

REFER ALSO TO CITATION(S) 33042, 33052, 33074, 33078, 33202, 33270

32996 **(BNL—37928) Prospects for SSC physics.** Paige, F.E. (Brookhaven National Lab., Upton, NY (USA)). Mar 1986. Contract AC02-76CH00016. 21p. (CONF-860168—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009918.

From Workshop on observable standard model physics at the SSC; Los Angeles, CA, USA (15 Jan 1986).

The SSC is primarily designed to explore the physics of the 1 TeV mass scale. Since new heavy particles will decay either into other new particles or into the quanta of the standard model, the main goal of SSC experiments will be to identify and to measure these quanta well. Progress in simulating events and in understanding the signature and backgrounds for standard-model physics is described. 51 refs.

32997 **(BNL—38034) ISAJET 5.20: a Monte Carlo event generator for pp and anti pp interactions.** Paige, F.E.; Protopopescu, S.D. (Brookhaven National Lab., Upton, NY (USA)). Mar 1986. Contract AC02-76CH00016. 17p. (CONF-860168—3). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010538.

From Workshop on observable standard model physics at the SSC; Los Angeles, CA, USA (15 Jan 1986).

ISAJET is a Monte Carlo program which simulates pp and anti pp interactions at high energy. It is based on perturbative QCD cross sections, leading order QCD radiative corrections for initial and final state partons, and phenomenological models for jet and

beam jet fragmentation. This article describes ISAJET 5.20, which includes a new model for beam jets in hard interactions. 25 refs.

32998 **(CBPF-NF—037/85) Gluon and q anti q mixing in the eta-eta' G (identical to iota (1440)) system.** Antunes, A.C.B.; Caruso, F.; Predazzi, E.; Tiomno, J. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1985. 28p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86701957.

A mixing scheme among three pseudoscalar mesons eta-eta' and iota (1440) is proposed in order to analyze their q anti q and gluonic components. Inequalities follow from requiring the consistency of the scheme and the range permitted for the mass of the pure gluonic state (glueball) turns out to be rather small. The resulting picture is in good agreement with the overall phenomenology and with the (rather scarce) data on the subject.

32999 **(CBPF-NF—062/85) Non-Abelian Aharonov-Bohm effect in the framework of Feynman pseudo-classical path integrals.** Botelho, L.C.L.; Mello, J.C. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro; Rio de Janeiro Univ. (Brazil). Inst. de Fisica). 1985. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701965.

The non-Abelian Aharonov-Bohm effect is analyzed in the Feynman Path Integrals framework generalized to pseudo-classical mechanics.

33000 **(DESY—85-132) Testing the WWγ coupling of the standard model at p anti p-colliders.** Cortes, J.; Herzog, F.; Hagiwara, K. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Bern Univ. (Switzerland). Inst. fuer Theoretische Physik). Dec 1985. 53p. (CERN-TH—4212/85). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751746.

The measurement of the magnetic moment μsub(W) of the weak boson W is crucial to test the non-abelian gauge theory of the electroweak interaction formulated by Glashow, Salam and Weinberg. We propose methods to measure μsub(W) at hadron colliders via the process p anti p->W$^-\gamma$X; W$^-$->l$^-$anti νsub(l) and p anti p->W$^-$X; W$^-$->γl$^-$anti νsub(l). The helicity amplitude of the parton sub-process factorize a la Mikaelian in lowest order of the fine structure constant α, leading to peculiar angular distributions among the initial and final state particles. We make extensive numerical studies at the Tevatron collider energy $\sqrt{s}$=2 TeV of these distributions applying experimentally feasible cuts. Furthermore we investigate the main background p anti p->W$^-$jetX; W$^-$->l$^-$anti νsub(l) where the jet fakes a single isolated photon. The effect of the finite W-width is discussed and found to be small. The sensitivity of our results to higher order QCD corrections is considered qualitatively but remains unknown quantitatively. (orig.).

33001 **(DESY—85-137) Is a light gluino still compatible with the CERN collider data.** Hagiwara, K. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Dec 1985. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751744.

The QCD 2->3 contribution to large missing transverse momentum events from light gluinos of mass 3-5 GeV is estimated by using the gluon-to-gluino splitting approximation to the squared matrix elements and the scale dependent gluino fragmentation function. The 2->3 processes give the dominant contribution over the 2->2 contribution, confirming the trend observed by Herzog and Kunszt for heavier gluinos. Most events have back-to-back jet configurations in both mono- and dijet events and would appear as an excess of jet-jet fluctuation at the CERN collider. Nonobservation of such effects in the 1984 data would rule out m sub(g tilde) down to 5 GeV but probably not below 3 GeV. (orig.).

33002 **(DESY—85-138) Monte Carlo study of the standard SU(2) Higgs model.** Langguth, W.; Weisz, P.; Montvay, I. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Theoretische Kernphysik; Hamburg Univ. (Germany, F.R.). 2. Inst. fuer Theoretische Physik). Dec 1985. 32p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751743.

The SU(2) Higgs model with scalar doublet field is numerically investigated on lattices with size between 8^4 and 12^4. Masses and zero momentum couplings are determined at several points of the three-dimensional coupling parameter space. Particular interest is given to questions related to the order of the confinement-Higgs phase transition. High statistics measurements in the region of nonperturbative scalar self-coupling and weak gauge coupling approximately equal to the physical value in the standard SU(2) x U(1) electro-weak theory give a Higgs-mass to W-mass ratio of 6.4+-0.8. The Higgs-WW coupling determined at these points is smaller than the value usually assumed in the standard model, implying that the width of the high mass Higgs-boson could still be relatively small, unless multi-W decays dominate. (orig.).

33003 **(DESY—86-006) Another higher order Langevin algorithm for QCD.** Kronfeld, A.S. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Jan 1986. 6p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751739.

This note provides an algorithm for integrating the Langevin equation which is second order. It introduces a term into the drift force which is a product of the Gaussian noise and a second derivative of the action. The specific application presented here is for nonabelian gauge theories interacting with fermions, e.g. QCD, for which it requires less memory than the Runge-Kutta algorithm of the same order. The memory and computational requirements of Euler, Runge-Kutta, and the present algorithm are compared. (orig.).

33004 **(INIS-mf—9878) Stochastic mechanics of a Dirac particle in two space-time dimensions.** De Angelis, G.F.; Jona-Lasinio, G.; Serva, M.; Zanghi, N. (Forschungszentrum Bielefeld-Bochum-Stochastik (BiBoS), Bielefeld (Germany, F.R.)). Sep 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751755.

BiBoS. No. 71.

We develop the stochastic mechanics of a Dirac particle interacting with an arbitrary external electromagnetic field in two dimensional Minkowski space. Our construction provides a consistent stochastic interpretation of solutions of the true (real time) Dirac equation and, in particular, gives a stochastic description of the Zitterbewegung. (orig.).

33005 (INIS-SU—320, pp 154-168) **Finite-energy analogs of Pomeranchuk theorems.** Vernov, Yu.S.; Mnatsakanova, M.N.; Chubarov, M.S. (Moskovskij Gosudarstvennyj Univ., USSR. Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki; Moskovskij Gosudarstvennyj Univ., USSR). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

The paper generalizes the Pomeranchuk theorem for finite energies. Restriction on the difference of $\Delta\sigma$ identy sign σsub(+)-σsub(-) total cross-sections for the given restriction on the growth of a real part of fsub(α)(E) antisymmetric amplitude i.e. directly "the Pomeranchuk theorem for finite energies has been obtained. Finite-energy analog of the Pomeranchuk inverse theory has been considered as well as restrictions on real and imaginary parts of fsub(s)(E) symmetric amplitude.

33006 (INIS-SU—320, pp 213-230) **Weak and electromagnetic interaction effects in a strong magnetic field.** Loskutov, Yu.M. (Moskovskij Gosudarstvennyj Univ., USSR). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

Asymptotics of quantum electrodynamics (QED) within the limit of a superstrong magnetic field is investigated. Field asymptotics of QED basic operators: electron propagator, polarization and mass operators and vertex function - is considered. Some effects of electromagnetic and weak interactions in a strong external magnetic field (two-photon production of neutrino pairs and nuclear electron bremsstrahlung) are discussed.

33007 (INIS-SU—320, pp 38-71) **Relativistic strings with a finite number of degrees of freedom.** Plyushchaj, M.S.; Pron'ko, G.P.; Razumov, A.V. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

Models obtained in freezing an infinite number of degrees of freedom of the Nambu-Goto relativistic string and the NeveuSchwartz string with fermion degrees of freedom and allowing quantization in four-dimensional space-time are suggested. A classical formulation of the Nambu-Goto relativistic string is considered. The model quantization is performed in the representation where the energy-string momentum vector is diagonal. The Neveu-Schwartz model was considered analogously. Analogs of the Newton-Wigner coordinates having the Dirac Zero brackets for the components were constructed for both systems. The classical and quantum theories of states with zero mass are investigated.

33008 (INIS-SU—320, pp 79-105) **Model of hadron elastic scattering and diffraction dissociation processes at high energies.** Troshin, S.M.; Tyurin, N.E. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A model of elastic scattering and processes of hadron diffraction dissociation for high energies is considered. The model is based on common properties of scattering-unitarity and analyticity matrix. Calculations were performed by means of equations of the field quantum theory for 2→2 and 2→n transition amplitudes. Representations on a hadron quark structure are used in constructing cores of these equations. A mechanism of polarization appearance of inclusive-produced Λ hydperons is investigated. The model suggested describes basic experimental regularities.

33009 (INIS-SU—320, pp 106-110) **Model of hadron elastic scattering and diffraction dissociation processes at high energies. 2. Asymptotic behaviour of hadron form factors.** Troshin, S.M.; Tyurin, N.E. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

Behaviour of elastic hadron form factors at high transferred momenta was studied within the framework of a quark model of elastic scattering and hadron diffraction dissociation processes. An asymptotic expression for hadron form factors was derived. Coupling between the asymptotic behaviour of elastic hadron form factors and the behaviour of complete cross-sections of the hadron interaction for high energies has been established.

33010 (INIS-SU—320, pp 111-126) **On a behaviour of the form factor of the π^0 meson decay in a Dalitz pair in a small invariant mass region.** Kozlov, G.A.; Kuleshov, S.P.; Sanadze, V.V.; Skachkov, N.B.; Savrin, V.I. (Joint Inst. for Nuclear Research, Dubna, USSR). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

The behaviour of $\pi^0 \to e^+ e^- \gamma$ decay form factor in the region of small invariant masses is investigated. A quasipotential approach in the quantum theory is applied for describing π^0 meson decay. The approach considered permits the determination of the type of relativistic wave functions describing relative quark motion. Solutions of three-dimensional relativistic equations for a fermion-antifermion system are used as model wave functions. It is concluded that the π meson structure must become apparent in the region of small values of the square of the Dalitz pair invariant mass.

33011 (INIS-SU—320, pp 127-134) **Finite-energy sum rules and their consequences.** Enkovskij, L.L.; Struminskij, B.V. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A method of finite-energy sum rules is applied for investigating deep inelastic lepton scattering with hadrons (DILSH). It is suggested that the DILSH structure function complies with q^2 dispersion relation (q^2-momentum transferred with current). The relation between the DILSH structure function and total hadron-hadron scattering has been found. It is shown that different sum rules used in quantum hydrodynamics result from finite-energy sum rules.

33012 (INIS-SU—320, pp 169-176) **KNO-scaling violation at superhigh energies.** Kajdalov, A.B.; Ter-Martirosyan, K.A. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A problem of KNO scaling violation in the case of superhigh energies is discussed within the framework of a string model of supercritical pomeron. In this model considering along with cutting cylindrical diagrams also polyperipherical diagrams the KNO scaling is approximate and is violated with energy growth. Theoretical predictions for the multiplicity distribution of charged particles in the anti pp interaction at 540 GeV are compared with new data of IA5 group. It is shown that experimental data of the IA5 group confirm the predictions of the pomeron string model.

33013 (INIS-SU—320, pp 231-238) **Non-leptonic weak baryon decays in the bag model.** Ebert, D.; Kallies, W. (Humboldt-Universitaet, Berlin, German Democratic Republic. Sektion Physik). 1984. NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

The review for charmed baryon decays based on the MJT-bag model is given. Some typical non-leptonic weak decays of the lower mass charmed baryons Λsub(c)sup(+), Asup(+,0) and T⁰ are discussed. The processes Λsub(c)sup(+)→(p anti Ksup(0), Ξsup(0)Ksup(+), Σsup(0)πsup(+)), Asup(+) → Ξsup(0)πsup(+), Asup(0) → Ξsup(-)πsup(+) and Tsup(0) → Ξsup(0) anti K sup(0) are considered. It is shown that the prediction for the rate GITA(Λsub(c)sup(+)→p anti Ksup(0)) is close to the experimental value GITA(Λsub(c)sup(+)→p anti Ksup(0))=(1.00sub(-0.78)sup(+0.86)10sup(11) ssup(-1.5)). The ratio of partial widths for the Σsup(0)πsup(+) and p anti Ksup(0) channels, GITA(Λsub(c)sup(+)→Σsup(0)πsup(+))consistent with recent data on Λsub(c)sup(+) decays obtained with Fermilab bubble chamber.

33014 (INIS-SU—320, pp 309-320) **On a behaviour of inclusive hadron processes at large transferred momenta and energies CERN ISR and SPS COLLIDER.** Drenska, S.B.; Mavrodiev, S.Shch.; Sisakyan, A.N. (Joint Inst. for Nuclear Research, Dubna, USSR). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

Behaviour of cross-sections of inclusive hadron processes for high transferred momenta is discussed. Data on cross-sections for the p anti p (pp) interactions measured at the CERN ISR and SPS COLLIDER accelerators are given. Possibility for describing the cross-sections of such reactions within the framework of rules of quark count of anomalous dimensionalities in QCD is considered. It is shown that in the leading logarithmic approximation the QCD rules of quark count of anomalous dimensionalities permit to describe experimantal data at >= 40 GeV energy values.

33015 (INIS-SU—320, pp 321-338) **New strict finite-energy upper and lower boundaries for hadron scattering amplitudes.** Kelemen, V.I.; Lomsadze, Yu.M. (Severo-Osetinskij Gosudarstvennyj Univ., Ordzhonikidze, USSR). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

Finite-energy upper and lower boundaries for hadron scattering amplitudes were obtained. The PIsup(+-)p→PIsup(+-)p reactions of forward scattering are considered. It is shown that different inequalities established with methods of the harmonic functions theory permit one to obtain not only asymptotic but also conditional finite-energy restrictions on hadron scattering amplitudes.

33016 (INIS-SU—320, pp 252-261) **Meson resonance production in the parton model with account for transverse quark motion.** Garsevanishvili, V.R.; Kartvelishvili, V.G.; Kuratashvili, G.O.; Topuriya, T.P.; Ehsakiya, Sh.M. (Tbilisskij Gosudarstvennyj Univ., USSR. Inst. Fiziki Vysokikh Ehnergij). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A quark-parton model of quark coalescence with provision for their transverse motion is discussed. Model predictions are compared with experimental distributions rhosup(0) and K* sup(+-)-mesons produced in the pp→rhosup(0)+chi and pp→K*sup(+-)+chi reactions at 12 and 24 GeV/c. The model describes well cross-sections of vector meson production in the above-mentioned reactions. It follows from the data contained in the paper that the constant of quark-antiquark pair coalescence to meson is independent of energy in the momentum range of 12-24 GeV/c.

33017 (INIS-SU—321, pp 323-336) **Effects of polarization and angular asymmetry of neutrino radiation in a magnetic field.** Loskutov, Yu.M. (Moskovskij Gosudarstvennyj Univ., USSR). 1984. (In Russian). NTIS (US Sales Only), PC A19/MF A01. File Number DE86780458. (CONF-8407160—Vol.1).

From 7. seminar on problems of high energy physics and quantum field theory; Protvino, USSR (1 Jul 1984).

Magnetic field effects on polarization states of electrons are investigated. It is shown that induced polarization of electrons along the field is possible under their irradiation by the electromagnetic wave shaped in the resonance with the difference of electron energy levels in the field and polarized in the plane parallel to the field. Expressions for polarization degree and relaxation time are given. The effect of angular asymmetry of neutrino radiation conditioned by magnetobreaking, photonuclear and other processes in the magnetic field is forecasted.

33018 (INIS-SU—321, pp 303-314) **On a hard inclusive spectrum of charm particles.** Slavnov, D.A. (Moskovskij Gosudarstvennyj Univ., USSR). 1984. (In Russian). NTIS (US Sales Only), PC A19/MF A01. File Number DE86780458. (CONF-8407160—Vol.1).

From 7. seminar on problems of high energy physics and quantum field theory; Protvino, USSR (1 Jul 1984).

Processes of charmed particle production in inclusive interactions are investigated. Data on the total cross-section of charmed particle production in proton-proton collisions are presented. The main contribution in the cross-section is made by quark-antiquark birth of charmed quarks. Inclusive spectra of charmed baryons and mesons are studied. For the same value of scaling variable x the number of D^0-mesons is two times the number of D^--mesons. The same ratio is true for anti D^0 and anti D^+ mesons.

33019 (INIS-SU—324, pp 20-23) **Possibilities of the search for short-lived Dsub(S)sup(0) mesons.** Tolstov, K.D.; Khushvaktova, A.; Shabratova, G.S. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of High Energy). 1984. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86780460.

In JINR rapid communications. Collection.

Premises for the existence and possibilities of the search for Dsub(S)sup(0)-mesons generated in collisions of fast hadrons with photoemulsion nuclei are investigated.

33020 (INP—1172/PH) **Spin effects in hadronic collisions at large momentum transfers.** Szwed, J. (Institute of Nuclear Physics, Krakow (Poland)). 1982. 78p. NTIS (US Sales Only), PC A05/MF A01. File Number DE86701958.

The role of the spin in hadron-hadron collisions at large psub(perpendicular) is investigated. The short distance diagrams and the end-point (x-1) contribution give phenomenologically similar results for the elastic nucleon-nucleon differential cross-section but differ significantly when looking at the spin-spin asymmetries. The spin analysis suggests the dominance of the end-point diagrams at large angles and present energies. The limits on the nucleon wave function are obtained from the comparison of spin effects in exclusive and inclusive reactions. Higher order results exclusive channels are reviewed. In the inclusive production we propose a simple model of baryon polarization at large transverse momentum which accounts qualitatively for all experimental data in these processes. Other models are also reviewed. The whole investigation suggests that the spin effects are a relatively clear probe of the complicated hadron dynamics.

33021 (ITEF—51(1984)) **Observation of kinematic resonance reflection in mass spectra of multiparticle reactions.** Aleshin, Yu.D.; Kiselevich, I.L.; Mel'nichenko, I.A.; Shkarlet, V.D.; Shidlovskij, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 31p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86701960.

The mechanism of kinematic reflection of resonances for the π^- rho → $n\pi^+\pi^+\pi^-\pi^-$ multiparticle reaction at 4.35 GeV/c momentum impinging π^- mesons, when events of this reaction were selected according to cosine of angle of particle divergence ($n\pi^+\pi^+\pi^-$) less than - 0.95 in the reaction center system, is considered. It is experimentally confirmed that the $\pi^-P \rightarrow rho^0\pi^+\Delta^-$ reaction takes place during this selection and taking account of this reaction together with the phase volume of the reaction describes satisfactorily experimental spectra in the $n\pi\pi$ particle system.

33022 (ITEP—118(1984)) **Magnetic moments of Δ-isobar and Ω^--hyperon in quantum chromodynamics.** Belyaev, V.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701961.

The magnetic moments of Δ-isobar and Ω^--hyperon are calculated using QCD sum rule method. The results obtained are by a factor of two smaller than the SU(6) quark model predictions.

33023 (JINR—R-2-85-198) **To the problem on a nature of the G(1590) meson.** Ivanov, M.A.; Muradov, R.Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics; Azerbajdzhanskij Gosudarstvennyj Univ., Baku (USSR)). 1985. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701964.

Submitted to the journal JETP Lett. .

The properties of the G(1590)-meson recently discovered are discussed in the framework of the quark-gluon-virton model. This model is based on the assumption that the interaction between hadrons in the low-energy region is due to the exchange by confined quark and gluon fields. It is shown that the present experimental data indicate that the G(1590)-meson is the gluonium.

33024 (MPI-PAE/Exp.El.—157) **Standard axion reconsidered.** Mageras, G. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik). Nov 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751758.

We show that within the standard axion model, there is an allowed range of short axion lifetimes which has not yet been excluded experimentally. The implications of this in connection with the possible production of a new neutral particle in heavy-ion collisions is discussed. We propose a new search for axion production in upsilon decays which would extend the test of the axion model to shorter lifetimes. (orig.).

33025 **(UFPB-DF—11/85) Bulk viscosity driven inflationary model.** Waga, I.; Falcao, R.C.; Chanda, R. (Paraiba Univ., Joao Pessoa (Brazil). Dept. de Fisica; Rio de Janeiro Univ. (Brazil). Inst. de Fisica). 1985. 6p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701966.

Bulk viscosity associated with the production of heavy particles during the GUT phase transition can lead to exponential or 'generalized' inflation. The condition of inflation proposed is independent of the details of the phase transition and remains unaltered in presence of a cosmological constant. Such mechanism avoids the extreme supercooling and reheating needed in the usual inflationary models. The standard baryongenesis mechanism can be maintained.

33026 **A simple method for computing the relativistic Compton scattering kernel for radiative transfer.** Prasad, M.K.; Kershaw, D.S.; Beason, J.D. (Lawrence Livermore National Laboratory, Livermore, California 94550). *Applied Physics Letters;* **48**: No. 18, 1193-1195(5 May 1986). Contract W-7405-ENG-48.

The Klein-Nishina differential cross section averaged over a relativistic Maxwellian electron distribution is analytically reduced to a single integral, which can then be rapidly evaluated in a variety of ways. This is, to our knowledge, the first correct computation of the Compton scattering kernel.

33027 **Deuteron as a soliton in the Skyrme model.** Braaten, E.; Carson, L. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201). *Physical Review Letters;* **56**: No. 18, 1897-1900(5 May 1986). Contract FG02-85ER40228.

The energy in the baryon-number-2 sector of the Skyrme model is shown to be minimized by a localized static soliton solution. If this solution has a particular discrete symmetry, the lowest-energy state of the soliton can have the spin, isospin, and parity quantum numbers of the deuteron. This identification is supported by approximate calculations of its charge radius and its magnetic and quadrupole moments.

33028 **Prediction of the four-generation Kobayashi-Maskawa matrix.** Johnson, R.; Schechter, J.; Gronau, M. (Physics Department, Syracuse University, Syracuse, New York 13244-1130). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 9, 2641-2652(1 May 1986). Contract FG02-85ER40231.

We give a detailed investigation of the four-generation case of our previously proposed model which predicts all the parameters of the Kobayashi-Maskawa matrix in terms of quark masses. An interesting aspect of this model is that both the t- and b′-quark masses are constrained to be relatively light. Furthermore the mixing with the fourth generation is fairly substantial and it typically makes an important contribution to the CP-violation parameter ϵ. .AE

33029 **Mirror-lepton phenomenology in a left-right model with ultralight Dirac neutrinos.** Albright, C.H.; Oliensis, J. (Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510 and Northern Illinois University, DeKalb, Illinois 60115). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 9, 2602-2607(1 May 1986). Contract W-31-109-ENG-38.

A study of the production and decay of heavy mirror leptons is presented in the framework of a left-right model that yields ultralight Dirac neutrinos. Qualitative limits on the masses of the light neutrinos are also presented in terms of bounds on the heavy-mirror-lepton masses.

33030 **Concavity of the quarkonium potential.** Bachas, C. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 9, 2723-2725(1 May 1986). Contract AC03-76SF00515.

The heavy-quark—antiquark potential is shown to be a monotone nondecreasing and concave function of the separation. This property holds independent of the gauge group and the details of the matter sector.

33031 **Factorization property of the deuteron.** Brodsky, S.J.; Ji, C. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 9, 2653-2659(1 May 1986). Contract AC03-76SF00515.

Using a simple field-theoretic model we show that, in the zero-binding limit, the relativistic deuteron wave function has a cluster decomposition; i.e., it factors into two separate nucleon wave functions convoluted with a body wave function. The framework of the calculation is a Fock-state expansion at equal time on the light cone. Assuming a quark-interchange mechanism, we then derive the deuteron reduced form factor at large momentum transfer, while recovering the standard impulse-approximation form at small momentum transfer.

33032 **Critical behaviour in baryonic matter.** Berg, B.; Engels, J.; Kehl, E.; Waltl, B.; Satz, H. (Florida State Univ., Tallahassee, USA. Dept. of Physics; Bielefeld Univ., Germany, F.R.. Fakultaet fuer Physik; Bielefeld Univ., Germany, F.R.. Fakultaet fuer Physik; Brookhaven National Lab., Upton, NY, USA. Physics Dept.). *Zeitschrift fuer Physik* [*Sektion*] *C: Particles and Fields;* **31**: No. 1, 167-174(May 1986).

First we consider the phenomenology of deconfinement and chiral symmetry restoration for strongly interacting matter at nonvanishing baryon number density. Subsequently, we present numerical results obtained by a Monte Carlo evaluation of statistical QCD on an 8^3 x 3 lattice, using Wilson fermions with Nsub(f)=2, in fourth order hoping parameter expansion, and supressing the imaginary part of the fermion action. We consider baryonic chamical potentials up to $\mu a=0.6$ (μ/Asub(L)approx.=200); in this range, the critical parameters for deconfinement and chiral symmetry restoration are found to coincide. (orig.).

33033 **Flavor-changing Yukawa coupling in the standard model and muon polarization in K/sub L/→μmu-bar.** Botella, F.J.; Lim, C.S. (Physics Department, Brookhaven National Laboratory, Upton, New York 11973). *Physical Review Letters;* **56**: No. 16, 1651-1654(21 Apr 1986). Contract AC02-76CH00016.

The muon longitudinal polarization P/sub L/ in K/sub L/ →μmu-bar decay is investigated in the standard model. The induced s-bardH vertex responsible for P/sub L/ turns out to be unexpectedly "large." The measurement of P/sub L/ above $\sim 10^{-3}$ will, therefore, be a signal of the existence of a rather light Higgs boson (M/sub H/< or $\approx$10 GeV). It is also shown that the mechanism of gauge-dependence cancellation between Higgs-boson-exchange and box diagrams works even in the standard model.

33034 **Higgs mass in Salam-Weinberg theory.** Beg, M.A.B. (Rockefeller Univ., New York, NY). pp 203-217 of Flavor mixing in weak interactions. Vol. 20. Chau, L.L. New York, NY; Plenum Press (1984). (CONF-8403113—).

From Europhysics conference; Erice, Italy (4 Mar 1984).

The Salam-Weinberg theory, of electroweak interactions, is discussed under the premise that the pure λ/phi/^{4} theory is trivial in four dimensions. Arguments underlying this premise are reviewed; it is shown that the requirement of consistency leads to an upper bound of about 125GeV for the Higgs-mass, if the mass of the top-quark is less than 80GeV and the theory is realized in the canonical way.

33035 **Experimental status of neutrino masses.** Boehm, F.H. (California Inst. of Technology, Pasadena, CA). pp 123-143 of Flavor mixing in weak interactions. Vol. 20. Chau, L.L. New York, NY; Plenum Press (1984). (CONF-8403113—).

From Europhysics conference; Erice, Italy (4 Mar 1984).

Neutrino physics faces a number of interesting challenges, among them are the following fundamental questions: Are neutrinos massive? Are physical neutrinos pure or mixed states? Are neutrinos Dirac or Majorana particles? Evidence for neutrino mass and mixing would lend support to grand unified theories or other schemes beyond the standard electroweak model. From astrophysics and cosmology, arguments can be made that the mass of neu-

trinos, summed over all flavors cannot exceed a value of about 100 eV. What are the experimental possibilities allowing tests for neutrino mass and neutrino mixing?

33036 **New results on flavor production at PEP.** Barbaro-Galtieri, A. (Univ. of California, Berkeley, CA). pp 273-318 of Flavor mixing in weak interactions. Vol. 20. Chau, L.L. New York, NY; Plenum Press (1984). (CONF-8403113—).

From Europhysics conference; Erice, Italy (4 Mar 1984).

This report includes results from five PEP detectors: DELCO, HRS, MAC, MARK II and TPC. All, except the TPC, are presently taking data at PEP. The TPC is being upgraded: a new superconducting coil is being installed and other improvements are being implemented. The results discussed here are either new or improved since the Cornell Conference. Other results from PEP have been reported at this Conference by George Trilling (MARK II) on /tau/, D /sub o/, and b lifetimes and a new limit on the tau neutrino mass, and by Bill Ford on the MAC measurement of the b lifetime. Section 2 will discuss new results on Particle Searches and a limit on neutrino generations. Section 3 includes new data on weak couplings of c and b quarks. In Section 4 various new results on hadron production are reported. Section 5 summarizes the new results. All data were obtained in e^+e^- collisions with total energy $\sqrt{s}$=29 GeV.

33037 **Status of rare decay experiments.** Littenberg, L.S. (Brookhaven National Laboratory, Upton, NY). pp 509-544 of Flavor mixing in weak interactions. Vol. 20. Chau, L.L. New York, NY; Plenum Press (1984). (CONF-8403113—).

From Europhysics conference; Erice, Italy (4 Mar 1984).

In the next few years rare decay experiments should provide stringent tests of the standard model. Limits on lepton flavor violating processes will be pushed down to levels of 10^{-11}-10^{-13} which correspond to new physics scales in the tens or hundreds of TeV. A number of K decays like K/sub L//sup O/ $\rightarrow e^+e^-$, π/sup O/ e^+e^-, $K^+ \rightarrow \pi^+ \nu^-\nu$, etc., will be probed down to or near the level of the highly suppressed standard model contribution, affording large windows for new physics.

33038 **Anomalons, honey and glue in nuclear collisions.** Gyulassy, M. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA). pp 237-273 of Short-distance phenomena in nuclear physics. Vol. 104. Boal, D.H.; Woloshyn, R.M. New York, NY; Plenum Press (1983). (CONF-8208213—).

From Pacific summer institute of the Theoretical Physics Division of the Canadian Association of Physicist; Vancouver, BC, Canada (23 Aug 1982).

This chapter covers three rapidly evolving areas of current research in the field of high energy nuclear collisions. Attempts to determine whether novel nuclear states exist, whether nuclei flow like honey, and whether a quark-gluon plasma can be produced. Examines anomalons, hungry quarks, pion condensation, global analysis, nuclear honey, nuclear stopping power and longitudinal growth, and proper energy density achieved. Reviews inconclusive data showing that collective nuclear flow could take place at lower energies. Presents cascade calculations illustrating various flow phenomena. Analyzes the prospects of probing the quark-gluon plasma. Investigates cosmic ray data with events showing charge particle multiplicities up to 1000. Concludes that high enough energy densities can indeed be achieved in nuclear collisions to produce an ideal quark-gluon plasma.

33039 **Pions from and about heavy ions.** Rasmussen, J.O. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA). pp 275-295 of Short-distance phenomena in nuclear physics. Vol. 104. Boal, D.H.; Woloshyn, R.M. New York, NY; Plenum Press (1983). (CONF-8208213—).

From Pacific summer institute of the Theoretical Physics Division of the Canadian Association of Physicist; Vancouver, BC, Canada (23 Aug 1982).

This chapter proposes that it is energetically possible to produce a pion when nuclei collide at energies in the center-of-mass system that exceed the rest mass energy of the pion of 140 MeV. Discusses pion thermometry; pion spectra; pionic orbits of nuclear size; pion confinement in the fireball; anomalons; and Schroedinger equation solutions for pionic atoms. Concludes that there is need for fundamental theoretical work to pin down the effects on the pion optical potential for multiple pions and the consequent di-delta admixtures. Notes that moderate alterations of the CMS potential of neutron-rich nuclei can give somewhat deeper bound pion s-states with lifetimes that can get into the anomalon range.

6453 Particle Invariance Principles And Symmetries

REFER ALSO TO CITATION(S) 33079

33040 **(DESY—85-143) Calculation of the O(αsub(s)^2) parity-violating structure functions in e^+e^-->q anti qg.** Koerner, J.G.; Schuler, G.; Kramer, G.; Lampe, B. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Mainz Univ. (Germany, F.R.). Inst. fuer Physik; Hamburg Univ. (Germany, F.R.). 2. Inst. fuer Theoretische Physik). Dec 1985. 49p. (MZ-TH—85-19). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751734.

We calculate the two nonvanishing O(αsub(s)^2) parity-violating structure functions that contribute to e^+e^-->q anti qg. We discuss how these can be measured. We work with massless quarks and gluons and use dimensional regularization to regularize ultraviolet and infrared singularities. We carefully discuss how to deal with γ_5 in the dimensional regularization scheme when infrared singularities are present. (orig.).

33041 **MIT bag model with chiral solitons.** Duck, I.; Reed, J. (Bonner Nuclear Laboratories, Physics Department, Rice University, Houston, Texas 77251). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 9, 2679-2687(1 May 1986).

A chiral-invariant version of the MIT bag model is solved numerically including the (σ,π,quark) interactions of the chiral-soliton model based on the Gell-Mann—Levy theory of hidden chiral symmetry. Rafelski's virial theorem is extended to the case of bagged quarks and provides a check of the numerical solutions. For strong meson-quark coupling, the bag plays almost no role and we recover a description of the nucleon similar to that of Birse and Banerjee. In the opposite limit, where the bag-confined quarks interact weakly with the σ and π mesons, we have a picture similar to the cloudy-bag model. Consideration of the pion-nucleon σ commutator favors the latter picture.

33042 **Weak mixing angles in unified theories.** Wali, K.C. (Syracuse Univ., Syracuse, NY). pp 434-458 of Flavor mixing in weak interactions. Vol. 20. Chau, L.L. New York, NY; Plenum Press (1984). (CONF-8403113—).

From Europhysics conference; Erice, Italy (4 Mar 1984).

The replication of families or generations with identical electroweak interactions in the low energy region presents a deep mystery. It is the historic e-μ puzzle in a considerably extended form. Horizontal or intragenerational interactions and the consequent mixing angles govern a wide range of phenomena concerning both old and new particles. In this review, I discuss the recent theoretical ideas and two specific models pertaining to horizontal symmetries.

6454 Field Theory

REFER ALSO TO CITATION(S) 33030, 33031, 33259

33043 **(BI-TP—86/1) Existence of localized solutions of (1+1)-dimensional non-linear Dirac equations with scalar self-finteraction.** Stubbe, J. (Bielefeld Univ. (Germany, F.R.). Zentrum fuer Interdisziplinaere Forschung; Forschungszentrum Bielefeld-Bochum-Stochastik (BiBoS), Bielefeld (Germany, F.R.); Bielefeld Univ. (Germany, F.R.). Fakultaet fuer Physik). 1986. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751756.

BiBoS. No. 128.

Necessary and sufficient conditions for the existence of localized solutions of the classical equations of motion for (1+1)-dimensional non-linear spinor fields are presented. Furthermore we give existence conditions for non-linear second order equations obtained

as a Klein-Gordon limit of the considered spinor field equations. (orig.).

33044 (BONN-HE—85-37) Classification of open string models. Nahm, W. (Bonn Univ. (Germany, F.R.). Physikalisches Inst.). Dec 1985. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751732.

Open string models are classified using modular invariance. No good candidates for new models are found, though the existence of an E_8 invariant model in Rsup(17,1), a similar one in Rsup(5,1) and of a supersymmetric model in Rsup(2,1) cannot be excluded by this technique. An intriguing relation between the left moving and right moving sectors of the heterotic string emerges. (orig.).

33045 (CBPF-NF—058/85) Scheme to unify gravity and electro-weak interactions. Novello, M.; Heintzmann, H. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro; Koeln Univ. (Germany, F.R.)). 1985. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701921.

The theory of electro-weak interactions and Jordan's description of Einstein's Theory of gravity are unified in a unique scheme. A short-range counterpart of gravity, involving massive tensor bosons of masses 365 GeV and 520,3 GeV, is obtained within the new scheme.

33046 (CONF-8603115—3) Are the Dirac strings harmless. Lipkin, H.J.; Peshkin, M. (Argonne National Lab., IL (USA); Weizmann Inst. of Science, Rehovoth (Israel)). 1986. Contract W-31-109-ENG-38. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010530.

From Symmetries in science II; Carbondale, IL, USA (24 Mar 1986).

The interaction of a magnetic charge with an external magnetic field due to electric currents is explored by means of a simple soluble model which includes the variables of the source of the magnetic field. In this model the Hamiltonian exists, the energy is conserved and the equations of motion are correct. However, in the limit where the current is externally fixed, paradoxes arise which appear to have serious implications for local theories based on Maxwell's fields or the vector potentials. Those paradoxes can be avoided by introducing Dirac strings, but then the strings appear not to be physically harmless. They imply the existence of a topological winding number variable which would not be present for a monopole without a Dirac string. 5 refs. (WRF)

33047 (DESY—85-135) Algorithm for high order strong coupling expansions: The mass gap in 3d pure Z_2 lattice gauge theory. Decker, K. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Bern Univ. (Switzerland). Inst. fuer Theoretische Physik; Hamburg Univ. (Germany, F.R.). 2. Inst. fuer Theoretische Physik). Dec 1985. 47p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751745.

An efficient description of all clusters contributing to the strong coupling expansion of the mass gap in three-dimensional pure Z_2 lattice gauge theory is presented. This description is correct to all orders in the strong coupling expansion and is chosen in such a way that it remains valid in four dimensions for gauge group Z_2. Relying on this description an algorithm has been constructed which generates and processes all the contributing graphs to the exact strong coupling expansion of the mass gap in the three-dimensional model in a fully automatic fashion. A major component of this algorithm can also be used to generate exact strong coupling expansions for the free energy logZ. The algorithm is correct to any order; thus the order of these expansions is only limited by the available computing power. The presentation of the algorithm is such that it can serve as a guide-line for the construction of a generalized one which would also generate exact strong coupling expansions for the masses of low-lying excited states of four-dimensional pure Yang-Mills theories. (orig.).

33048 (DESY—85-141) Updating fermions with the Lanczos method. Barbour, I.M.; Behilil, N.E.; Gibbs, P.E.; Rafiq, M.; Moriarty, K.J.M.; Schierholz, G. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Glasgow Univ. (UK). Dept. of Natural Philosophy). Dec 1985. 17p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751740.

The Lanczos method is proposed for the Monte Carlo simulation of the QCD (lattice) vacuum including dynamical fermion loops. It appears that an exact fermion update is feasible on medium sized lattices with today's vector processors. (orig.).

33049 (DESY—85-144) Volume dependence of the energy spectrum in massive quantum field theories. Pt. 1. Stable particle states. Luescher, M. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Dec 1985. 62p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86751735.

Due to polarization effects, the mass M of a stable particle in a quantum field theory enclosed in a large (space-like) box of size L and periodic boundary conditions in general differs from its infinite volume value m. As L increases, the finite size mass shift $\Delta m = M - m$ goes to zero exponentially with a rate, which depends on the particle considered and on the spectrum of light particles in the theory. This behaviour follows from an apparently universal asymptotic formula, already presented earlier, which relates Δm to certain forward elastic scattering amplitudes. A detailed proof of this basic relation is given here to all orders of perturbation theory in arbitrary massive quantum field theories. (orig.).

33050 (DESY—86-003) Line of second order phase transitions in the 4-dimensional Z_2 gauge theory with matter fields. Filk, T.; Marcu, M.; Fredenhagen, K. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.); Freiburg Univ. (Germany, F.R.). Fakultaet fuer Physik; Hamburg Univ. (Germany, F.R.). 2. Inst. fuer Theoretische Physik). Jan 1986. 13p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751738.

We present strong evidence that the phase transition between the free charge and the screening region of the 4-dimensional Z_2 lattice gauge theory with Z_2 matter fields is second order with mean field exponents. The quantity best suited for the analysis is an order parameter that tests the existence of charged states. We determine both its scaling and finite size scaling properties by performing a Monte-Carlo simulation. (orig.).

33051 (DOE/ER/40176—02) Particle theory and cosmology. Final report, July 16, 1984-March 31, 1986. Shafi, Q. (Delaware Univ., Newark (USA). Bartol Research Foundation). 17 Apr 1986. Contract FG02-84ER40176. 8p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010366.

The major thrust of the research reported was in the area of unified theories, in particular in grand unified and higher dimensional superstring theories. The problems that were addressed included: (1) the construction of realistic "low energy" (four dimensional) gauge models motivated from the ten-dimensional $E_8 \times E_8$ superstring theory; (2) a study of the phenomenological and cosmological implications of such models; (3) implementation of the inflationary scenario in the context of higher dimensional theories of gravity; and (4) clarification of the role of extended structures such as strings, monopoles and domain walls in a cosmological setting, particularly in an inflationary cosmology.

33052 (INIS-mf—9882) Probabilistic solutions of generalized birth and death equations and application to non-relativistic electrodynamics. Serva, M. (Forschungszentrum Bielefeld-Bochum-Stochastik (BiBoS), Bielefeld (Germany, F.R.)). 1986. 27p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751757.

BiBoS. No. 129.

In this paper we give probabilistic solutions to the equations describing non-relativistic quantum electrodynamical systems. These solutions involve, besides the usual diffusion processes, also birth and death processes corresponding to the 'photons number' variables. We state some inequalities and in particular we establish

bounds to the ground state energy of systems composed by a non relativistic particle interacting with a field. The result is general and it is applied as an example to the polaron problem. (orig.).

33053 (INIS-SU—320, pp 239-251) **To the theory of particles with half-integer spin.** Bogush, A.A.; Kisel', V.V. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

Some aspects of the theory of relativistic wave equations (RWE) applied for describing particles with half-integer spin are considered. The Gelfand-Yaglom modified basis, which facilitates, proceeding from physical requirements, finding RWE matrixes of the explicit form is suggested. A technique is developed for transition from RWE given in an explicit spinor form to their recording in a universal matrix form by introduction of generalized spinor Kronecker symbols. It is shown on this basis that in proper choice of a source set of irreducible representations of the Lorentz group the introduction of the electromagnetic interaction provides, to a minimal degree, the description of an additional interaction resulting from the presence of anomalous magnetic moment in a particle with 3/2 spin.

33054 (INIS-SU—320, pp 272-283) **Equations of relativistic string imbedding into 6-dimensional space-time and their general solution.** Barbashov, B.M.; Koshkarov, A.L.; Nesterenko, V.V. (Joint Inst. for Nuclear Research, Dubna, USSR). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A set of 5 differential equations with 5 unknown functions describing a world surface of relativistic string in six-dimensional space-time has been derived. It is shown how a general solution of the given set can be obtained. This solution isn't written down completely due to its complicated form. The suggested method for deriving and solving equations can be used in the case of arbitrary space-time dimensionality.

33055 (INIS-SU—320, pp 28-37) **Quantum field theoretic properties of nonabelian phase factors.** Wieczorek, E. 1984. NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

The paper is concerned with quantum field theoretical properies of nonabelian phase factors. The phase factors defining parallel transport in fiber bundle space are the necessary tool for the construction of gauge invariant nonlocal operators describing bound states in QCD. General structures of such operators are discussed and renormalization properties as well as relations between meson and baryon operators are obtained from a study of the underlying phase factors.

33056 (INIS-SU—320, pp 177-186) **Dual invariance and dyons in nonabelian gauge theories.** Tolkachev, E.A.; Tomil'chik, L.M. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A procedure of the Jang-Mills equations representatian in a dually-invariant form for the case of an arbitrary gauge group has been demonstrated. At that, as in electrodynamics, the principle of dual invariance of observables is formulated which, as it is shown, in the non-abelian case fixes unambiguously the charge dependence of the dyon mass.

33057 (INIS-SU—320, pp 187-199) **Gauge theory of particles with maximum 3/2 spin.** Kruglov, S.I.; Strazhev, V.I. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

It is shown that the theory of particles with variable spin permits one to develop a new approach different from existing ones to the construction and dynamic interpretation of the nonabelian gauge theory. A model of relativistic-covariant description of spinor fields where the gauge theory of particles with variable spin is renormalized unitary and asymptotically free, is suggested.

33058 (INIS-SU—320, pp 200-212) **Polarization symmetries of field theories.** Strazhev, V.I.; Shkol'nikov, P.L. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A theoretical group approach to the description of reactions with polarized particles is investigated. The approach permits to suggest a method for considering nopgeometric (polarization) symmetries of relativistic wave equations. It is concluded that the theoretical group approach to the description of the polarized particle reactions is a direct consequence of existence of polarization symmetries intrinsic to any wave equation describing a spin particle.

33059 (INIS-SU—320, pp 353-368) **Effective electrodynamics and gravity in a nonlinear spinor theory.** Durr, H.P. (Max-Planck-Institut fuer Physik und Astrophysik, Muenchen, Germany, F.R. Werner-Heisenberg-Inst. fuer Physik). 1984. NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

In contrast to the usual unified theories of elementary particles the present approach aims at a "radical unification" suggested by W. Heisenberg and based on the following three premises; a minimum number of constituent local fields with a minimum number of components, a maximum invariance group for the dynamics of these minimum fields, a sufficiently strong nonlinearity.

33060 (INIS-SU—320, pp 339-352) **Broken local commutativity axioms for universal Wightman field.** Krivsky, I.Yu.; Lomsadze, Yu.M.; Sabad, E.P.; Dobony, V.I. (Severo-Osetinskij Gosudarstvennyj Univ., Ordzhonikidze, USSR). 1984. NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A weak nuclearity of the space Usub(F) with arbitrary F is proven. The local properties of number-valued generalized functions U contains Usub(F)sup(n) are extended to the operator-valued generalized functions. The latter together with the weak nuclearity of the space Usub(F) give the possibility to formulate in a weak form both the local commutativity axiom and the broken local commutativity axiom keeping the psub(+)-invariance of the theory. Both axioms are formulated in terms of reductions of the field to the Borel sets.

33061 (INIS-SU—320, pp 262-271) **Dynamic equations for gauge-invariant wave functions.** Kapshaj, V.N.; Skachkov, N.B.; Solovtsov, I.L. (Gomel'skij Gosudarstvennyj Univ., Byelorussian SSR; Joint Inst. for Nuclear Research, Dubna, USSR; Gomel'skij Politekhnicheskij Inst., Byelorussian SSR). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

The Bethe-Salpeter and quasipotential dynamic equations for wave functions of relative quark motion, have been derived. Wave functions are determined by the gauge invariant method. The V.A. Fock gauge condition is used in the construction. Despite the translational noninvariance of the gauge condition the standard separation of variables has been obtained and wave function doesn't contain gauge exponents.

33062 (INIS-SU—321, pp 337-342) **Realization of irreducible representations of the IU(1,3) group in generalized quark fields.** Khrushchev, V.V. 1984. (In Russian). NTIS (US Sales Only), PC A19/MF A01. File Number DE86780458. (CONF-8407160—Vol.1).

From 7. seminar on problems of high energy physics and quantum field theory; Protvino, USSR (1 Jul 1984).

A noncompact IU(1,3) group containing the Poincare P(1,3) group is considered to describe space-time properties of quarks. Properties of IU(1,3) group and its representations are given. The notion of the generalized quark field which in non-trivial cases necessarily contains fields with different spins is introduced.

33063 (INIS-SU—325, pp 39-42) **On the gauge-invariant variables for non-Abelian theories.** Skachkov, N.B.; Shevchenko, O.Yu.; Solovtsov, I.L. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of Theoretical Physics; Gomel'skij Politekhnicheskij Inst., Byelorussian SSR). 1985. NTIS (US Sales Only), PC A04/MF A01. File Number DE86780459.

In JINR rapid communications. Collection.

Gauge invariant field variables are proposed for the case of non-Abelian field theories. The relation of these variables with the gauge-invariant strength tensor is found. It is shown that the Lorentz gauge condition formulated in terms of Mandelstam's contour derivatives takes place for new field variables and it serves as a secondary constraint according to Dirac's definition.

33064 (INP—1178/PH) **Gluonic Regge singularities and anomalous dimensions in QCD.** Jaroszewicz, T. (Institute of Nuclear Physics, Krakow (Poland)). 1982. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701959.

The Regge calculus results on the perturbative Pomeron are applied to deep inelastic scattering. Explicit expressions are given for the anomalous dimensions γsub(GGG)sup(n) and γsub(GF)sup(n) at n approx.= 1 to the lowest order in α and all orders in α/(n-1).

33065 (ITEP—8(1985)) **Decay of false vacuum in (1+1) dimensions.** Voloshin, M.B. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 21p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701922.

The decay rate of a false vacuum in (1+1) dimensions is expressed by a universal closed formula, which contains only two parameters: the mass of soluiton and the difference of energy density of the initial and the final states. The relative magnitude of corrections to the formula vanishes in the limit of vanishing energy difference. The formula is derived by the effective action technique and applicability of the Feynman perturbation theory is not assumed.

33066 (ITEP—31(1985)) **Supersymmetric instanton calculus. Gauge theories with matter.** Novikov, V.A.; Shifman, M.A.; Vainshtein, A.I.; Zakharov, V.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1985. 47p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86701926.

Correlation functions of the type $(W^2(x), S^2(0))$ where S is the chiral matter superfield (in the one-flavor model) are discussed within the framework of gauge SUSY theories. SUSY implies that these correlation functions do not depend on coordinates and vanish identically in perturbation theory. A technique is developed for the systematic calculation of instanton effects. It is shown that even in the limit $x \to 0$ the correlation functions at hand are not saturated by small-size instantons with radius rho approximately x; a contribution of the same order of magnitude comes from the instantons of characteristic size pro approximately 1/V (V is the vacuum expectation value of the scalar field, and the attention is paid to the models with $V >> \Lambda$ where Λ is the scale parameter fixing the running gauge coupling constant). If $V > \Lambda$ both types of instantons can be consistently taken into account. The computational formalism proposed is explicitly supersymmetric and uses the language of instanton-associated superfields.

33067 (ITEP—167(1984)) **Witten index calculation in supersymmetric gauge theory.** Smilga, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 19p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701925.

Direct calculation of the Witten index Isub(W) in the SU(2) SUSY Yang-Mills theiory is performed using the periodic boundary conditions. Our result is Isub(W)=1 which disagrees with the Witten's result: Isub(W)=N for the SU(N) gauge group. The principle physical conclusion of SUSY unbreaking in this theory remains intact.

33068 (JINR—E-2-85-203) **Gauge-invariant variables and infrared confinement in QCD.** Pervushin, V.N.; Azimov, R.I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1985. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701962.

Submitted to the journal Theor. Math. Phys. .

The gauge-invariant approach to quantization of the non-Abelian theory in a finite-volume space-time is considered. In this theory the topological vacuum degeneration takes place, and this degeneration may be a physical cause of nonobservation of free colour particles.

33069 (JINR—R-2-84-603) **QCD asymmetry and measurement of structure functions of polarized hadron.** Efremov, A.V.; Teryaev, O.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1984. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701963.

Submitted to the journal Phys. Lett. .

Polarization phenomena are discussed in the framework of high energy physics. It is shown that in hard processes with a polarized particle the contributions proportional to two-index distribution functions (correlation densities of parton number) have imaginary parts even in a Born subprocess. They represent the source of large single asymmetries. Calculation of such asymmetry in the $\gamma P \to \gamma X$ process, which appears to be a good partonometer for correlation densities was conducted.

33070 (LA-UR—86-1116) **Monte Carlo Renormalization Group: a review.** Gupta, R. (Los Alamos National Lab., NM (USA)). 1985. Contract W-7405-ENG-36. 30p. (CONF-8511170—2). NTIS, PC A03/MF A01; GPO Dep. File Number DE86010161.

From Lattice gauge theory: a challenge in large scale computing conference; Wuppertal, F.R. Germany (5 Nov 1985).

The logic and the methods of Monte Carlo Renormalization Group (MCRG) are reviewed. A status report of results for 4-dimensional lattice gauge theories derived using MCRG is presented. Existing methods for calculating the improved action are reviewed and evaluated. The Gupta-Cordery improved MCRG method is described and compared with the standard one. 71 refs., 8 figs.

33071 (LA-UR—86-1306) **Strings and their compactification from the particle viewpoint.** Slansky, R. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 52p. (CONF-860287—1). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010186.

From Utah State theoretical physics workshop; Logan, UT, USA (24 Feb 1986).

A series of four lectures is given which deals with the particle formulation of string theory. An introductory lecture is given on where the idea of strings comes from and what strings are. An introduction is given to simple Lie algebras and their representations. Compactified strings and the heterotic theories are discussed, showing how infinite-dimensional Kac-Moody affine algebras can be spectrum generating algebras in (open) string theories. The spectrum of excited states of the heterotic string is examined, and comments are made on representations of affine algebras. Some aspects are shown of the algebraic structure of compactified closed bosonic strings. (LEW)

33072 **(LA-UR—86-1333) Introduction to string field theory.** Lykken, J.; Raby, S. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 33p. (CONF-860287—2). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010189.

From Utah State theoretical physics workshop; Logan, UT, USA (24 Feb 1986).

An action is proposed for an interacting closed bosonic string. Our formalism relies heavily on ideas discussed by Witten for the open bosonic string. The gauge fixed quantum action for the fully interacting open bosonic string is obtained.

33073 **(LA-UR—86-1492) Introduction to string field theory. A pedestrian approach to the covariant formulation.** West, G.B. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 43p. (CONF-860150—2). NTIS, PC A03/MF A01; GPO Dep. File Number DE86010209.

From Winter condensed matter physics conference: frontiers in condensed matter X-ray physics; Aspen, CO, USA (19 Jan 1986).

A relatively elementary account is given of what a string field represents and what is involved in the construction of its covariant action. Emphasis is on drawing a correspondence with similar problems in ordinary field theory and, particularly, using the language and mathematics used in ordinary field theory. Only the free string is discussed. 17 refs., 3 figs. (LEW)

33074 **(RAL—85-088) Axial anomaly suppression (and axial U(1) symmetry restoration) at high temperatures: a lattice Monte Carlo study.** Teper, M. (Rutherford Appleton Lab., Chilton (UK)). Oct 1985. 12p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701923.

The topological charge density in the non-Abelian SU(2) vacuum as a function of temperature is calculated. It is found that the topological susceptibility is strongly suppressed for temperatures above the deconfining (chiral) phase transition.

33075 **(RAL—85-089) Topological susceptibility in SU(2) lattice gauge theory: an exploratory study.** Teper, M. (Rutherford Appleton Lab., Chilton (UK)). Oct 1985. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701924.

The local topological charge density of the SU(2) vacuum is measured, using an algorithm that has the correct continuum limit and is not contaminated by perturbative contributions or dislocations. The resulting susceptibility, xsub(t) approx. (130 MeV)^4, is smaller than that obtained by "geometric" methods and is suppressed at small physical lattice volumes. Various systematic biases are quantified: finite volume effects, reaching equilibrium and uniqueness of the topology. The author comments on the role of instantons and presents an inequality between xsub(t) and the gluon condensate. It is found that a significant fraction of the non-perturbative action resides in extended topological objects.

33076 **Superspace formulation of ten-dimensional N = 1 supergravity coupled to N = 1 super Yang-Mills theory.** Atick, J.J.; Dhar, A.; Ratra, B. (Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 2824-2832(15 May 1986). Contract AC03-76SF00515.

We present an on-shell superspace formulation of ten-dimensional N = 1 supergravity coupled to N = 1 super Yang-Mills theory. The coupling is completely specified in superspace by the Bianchi identity $dH = c_1 trF^2$, where H is the gauge-invariant three-form field strength of supergravity and F is the two-form super Yang-Mills field strength. We also briefly discuss the theory that results from modifying this Bianchi identity by the addition of a piece proportional to the square of the super curvature two-form.

33077 **Dirac quantization in superspace.** Barcelos-Neto, J.; Das, A. (Department of Physics and Astronomy, University of Rochester, Rochester, New York 14627). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 2863-2869(15 May 1986). Contract AC02-76ER13065.

We extend the method of Dirac quantization to superspace. We study simple models like the supersymmetric quantum mechanics as well as the supersymmetric nonlinear σ model in 1+1 dimensions. Although in both these cases the matrix representing the Poisson brackets between the constraints is singular, we show, following the spirit of Dirac, that one can still define Dirac brackets and that the resulting quantization is consistent with those of the component fields.

33078 **Fermion—grand-unified-monopole systems as exactly solvable two-dimensional quantum-field-theory problems.** Craigie, N.S. (Brookhaven National Laboratory, Upton, New York 11973). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 2930-2943(15 May 1986). Contract AC02-76CH00016.

We develop a framework for treating the interaction of light fermions with an arbitrary spherically symmetric grand-unified-theory monopole, which takes into account all the quantum fields outside the core. By identifying an underlying minimally extended Kac-Moody algebra, we show that in many cases, if not all, these systems reduce to an exactly solvable two-dimensional quantum-field-theoretic problem, in which all the interesting correlation functions can in principle be explicitly computed.

33079 **SU(2) deconfinement temperature on a body-centered hypercubic lattice.** Celmaster, W.; Kovacs, E.; Green, F.; Gupta, R. (Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 3022-3030(15 May 1986). Contract W-31-109-ENG-38.

We present a Monte Carlo analysis of the SU(2) finite-temperature deconfinement transition on a body-centered hypercubic lattice. The behavior of the transition temperature T/sub c/ as a function of the lattice coupling β appears to deviate from the perturbative prediction of asymptotic scaling.

33080 **Dimensional reduction near a phase transition.** Rohrlich, D. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973 and Institute for Theoretical Physics, State University of New York, Stony Brook, New York 11794). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 3031-3038(15 May 1986). Contract AC02-76CH00016.

The dimensional-reduction hypothesis is tested in theories with a first-order phase transition. Five-dimensional SU(2) lattice gauge theory has a confined phase which resembles the two-dimensional theory; across the phase transition this resemblance is lost and the string tension vanishes. A similar pattern is found for reduction from four-dimensional SO(3) to the two-dimensional SO(3) theory. An external random flux does not induce reduction where it is not spontaneously present.

33081 **Quenched massive Schwinger model in the infrared approximation.** Guerin, F.; Fried, H.M. (Laboratoire de Physique Theorique, Universite de Nice, Parc Valrose, 06034 Nice Cedex, France). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 3039-3054(15 May 1986). Contract AC02-76ER03130.

In the quenched, continuum version of the Schwinger model, a gauge-invariant summation over soft photons exchanged across a fermion loop is performed for the order parameter <psi-bar psi> and the correlation function <psi-bar psi(x) psi-bar psi(y)> with a fermion mass mnot =0 and photon momentum k<m. The limit m→0 leads to a finite, nonzero value for <psi-bar psi>; in the correlation function the leading terms, proportional to <psi-bar psi>^{2}, cancel between the two types of diagrams leaving free massless propagation.

33082 **Supersymmetry and zero-momentum modes.** Itoyama, H. (Fermi National Accelerator Laboratory, P.O. Box 500, Batavia, Illinois 60510). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 3060-3074(15 May 1986).

Massless super quantum electrodynamics (SQED) and massless U(N) SQCD are examined in the somewhat improved Born-Oppenheimer approximation. The leading asymptotic behaviors of the wave functionals are fully respected. Supersymmetry is shown to be unbroken in both cases. CP or R symmetry is spontaneously

broken. The Witten index in these theories is well defined despite the abnormal degeneracy, and the values agree with their massive counterparts. Clarification in connection with other approaches is made.

33083 **Tricritical ratio of length scales in D = 4 Abelian Higgs model.** Kleinert, H. (Department of Physics, University of California, San Diego, La Jolla, California 92093). *Physical Review Letters;* **56**: No. 14, 1441-1443(7 Apr 1986). Contract AS03-81ER40029.

We use the duality between the Abelian Higgs model and pure U(1) lattice gauge theory to estimate the ratio $\sqrt{2}\ \kappa$ equivalent λ/ξ of penetration depth and coherence length at the tricritical point to be $\sqrt{2}\ \kappa$ roughly-equal 0.93, thus placing the tricritical point slightly on the type-I side of the borderline between type-I and type-II superconductivity in four dimensions.

33084 **Chaos in radiative interactions.** Ackerhalt, J.R.; Galbraith, H.W.; Milonni, P.W. (Theoretical Division (T-12), Los Alamos National Laboratory, Los Alamos, NM). pp 97-166 of Quantum Electrodynamics and quantum optics. Barut, A.O. New York, NY; Plenum Press (1984). (CONF-8305249—).

From NATO advanced study institute on quantum electrodynamics and quantum optics; Boulder, CO, USA (27 May 1983).

Our purpose here is to indicate why chaotic dynamics may be of interest in the study of radiative interactions in quantum optics.

33085 **AXp or rXE? Minimal coupling and multipolar Hamiltonians in the quantum theory of radiation.** Haller, K. (Department of Physics, University of Connecticut, Storrs, CT). pp 373-391 of Quantum Electrodynamics and quantum optics. Barut, A.O. New York, NY; Plenum Press (1984). (CONF-8305249—).

From NATO advanced study institute on quantum electrodynamics and quantum optics; Boulder, CO, USA (27 May 1983).

The minimal coupling Hamiltonian is consistent with Maxwell's equations and with the Schroedinger equation. When A /sub lm/ is quantized, and the necessary constraints are properly implemented, the gauge-dependent parts of this Hamiltonian are manifestly unable to affect any of its dynamical consequences. It is the minimal coupling Hamiltonian, not the multipolar Hamiltonian, whose validity in time-evolution equations may be taken for granted. The multipolar Hamiltonian cannot be obtained from the minimal coupling Hamiltonian by making a gauge transformation. The multipolar Hamiltonian can be obtained from the minimal coupling Hamiltonian by a unitary transformation.

33086 **The spectrum in lattice gauge theories.** Berg, B. (Institut fur Theoretische Physik, Luruper Chaussee 149, Hamburg). pp 105-196 of Progress in gauge field theory. 't Hooft, G.; Jaffe, A.; Lehmann, H.; Mitter, P.K.; Singer, I.M.; Stora, R. New York, NY; Plenum Press (1984). (CONF-8309231—).

From NATO advanced study institute on progress in gauge field theory; Cargese, France (1 Sep 1983).

A critical status report on spectrum calculations for 4d SU(2) and SU(3) lattice gauge theories (without quarks) is given. Also some conceptual details are discussed.

33087 **Lattices, demons and the microcanonical ensemble.** Bhanot, G. (The Institute for Advanced Study, Princeton, NJ). pp 155-167 of Progress in gauge field theory. 't Hooft, G.; Jaffe, A.; Lehmann, H.; Mitter, P.K.; Singer, I.M.; Stora, R. New York, NY; Plenum Press (1984). (CONF-8309231—).

From NATO advanced study institute on progress in gauge field theory; Cargese, France (1 Sep 1983).

A method proposed recently for computer simulation of dynamical systems is investigated in detail for the Ising model.

33088 **Valon model for hadrons and their interactions.** Hwa, R.C. (Univ. of Oregon, Eugene, OR). pp 79-99 of Short-distance phenomena in nuclear physics. Vol. 104. Boal, D.H.; Woloshyn, R.M. New York, NY; Plenum Press (1983). (CONF-8208213—).

From Pacific summer institute of the Theoretical Physics Division of the Canadian Association of Physicist; Vancouver, BC, Canada (23 Aug 1982).

This chapter outlines how the hadron structure is determined in terms of the valons and how hadronic reactions can then be described in the valon framework. Shows how two aspects of the hadron, the bound-state and scattering properties, can be combined in a unified picture that can be applied to explaining many empirical facts that have been accumulated in the past 20 yrs. Examines the valon model, deep inelastic scattering, hadronization, low-P/sub T/ inclusive reactions, and problems in hadron physics (form factors, Regge behavior of elastic amplitudes, radiation length of fast quarks in nuclear matter, quark-gluon plasma in heavy ion collisions). Omits discussion of the subject of photon fragmentation as a result of deep inelastic probing. Suggests the establishment of a connection with triple Regge analysis.

33089 **Nuclear chromodynamics: Implications of QCD for nuclear physics.** Brodsky, S.J. (Stanford Univ., Stanford, CA). pp 141-217 of Short-distance phenomena in nuclear physics. Vol. 104. Boal, D.H.; Woloshyn, R.M. New York, NY; Plenum Press (1983). (CONF-8208213—).

From Pacific summer institute of the Theoretical Physics Division of the Canadian Association of Physicist; Vancouver, BC, Canada (23 Aug 1982).

This chapter discusses the synthesis of quantum chromodynamics (QCD) with nuclear physics (nuclear chromodynamics). Examines exclusive processes in QCD; applications to nuclear amplitudes; reduced nuclear amplitudes; QCD and the nucleon-nucleon interaction; nuclei as probes of particle physics dynamics; parity violation in hadronic or nuclear processes; the nucleus as a color filter; nuclear corrections to inclusive QCD reactions; propagation of quark and gluon jets in nuclear targets; nuclear shadowing; hadronic wave functions and their measurements in QCD; relativistic wave functions of composite systems; measures of hadronic wave functions; form factors of mesons; the meson distribution amplitude; general large momentum transfer exclusive processes; two-photon processes; the phenomenology of hadronic wave functions; QCD predictions for the deuteron form factor and the deuteron distribution amplitude; further applications of reduced nuclear amplitudes; and limitations of traditional nuclear physics. Suggests that QCD could be the theory of strong and nuclear interactions in the same sense that QED accounts for electrodynamic interactions. Finds that QCD solves many crucial problems (e.g., the meson and baryon spectra, quark statistics).

6455 Scattering Theory

REFER ALSO TO CITATION(S) 33244

33090 (INIS-SU—320, pp 135-143) **Equality of some integrals from real and imaginary parts of a scattering amplitude.** Vernov, Yu.S.; Konovalov, A.V.; Mnatsakanova, M.N. (Moskovskij Gosudarstvennyj Univ., USSR. Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

The relation between the behaviour of real and imaginary parts of a forward elastic scattering amplitude is investigated on the basis of analyticity and crossing symmetry. The possibility for the generalization of this equality also for symmetric amplitudes resulting from dispersion relations was considered. It is noted that the investigation performed is true for any function complying with the dispersion relation, for example, for the polarization operator.

33091 (INIS-SU—320, pp 144-153) **Practical analyticity of scattering amplitudes.** Vernov, Yu.S.; Chubarov, M.S. (Moskovskij Gosudarstvennyj Univ., USSR). 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

It is shown that the scattering amplitude analyticity in the whole E plane, excluding a real axis, can be actually used for all the processes of two-particle scattering and for random physical values of a transferred momentum. For this purpose a modified delay amplitude, modified leading amplitude and modified "physical" amplitude have been constructed.

33092 **Group theory approach to scattering. II. The Euclidean connection.** Alhassid, Y.; Guersey, F.; Iachello, F. (A. W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06511). *Annals of Physics (New York);* **167**: No. 1, 181-200(Mar 1986). Contract AC02-76ER03074;AC02-76ER03075.

We show that the calculation of the S-matrix associated with a class of solvable potentials with SU(1,1) dynamic symmetry can be formulated in purely algebraic terms. This formulation makes use of the Euclidean group in two dimensions, E(2), and is amenable to generalization to a larger number of dimensions.

65 PHYSICS II

6510 Nuclear Physics

REFER ALSO TO CITATION(S) 32523, 32978, 32979, 33173

33093 **(BARC—1282) Report of the Nuclear Physics Division [for the period] January 1, 1984 to December 31, 1984.** Dasannacharya, B.A.; Bansal, M.L.; Jain, A.K. (Bhabha Atomic Research Centre, Bombay (India)). 1985. 123p. NTIS (US Sales Only), PC A06/MF A01. File Number DE86701985.

The Research and Development (R and D) activities of the Nuclear Physics Division of the Bhabha Atomic Research Centre, Bombay, during 1984 are described in the form of individual summaries grouped under the broad headings: (1) nuclear physics, (2) solid state physics, and (3) techniques and instrumentation. The research programmes in the field of nuclear physics are based on the facilities: the 5.5 MV Van-de-Graaff accelerator and the CIRUS reactor, both at Bombay, and the variable energy cyclotron at Calcutta. Solid state physics studies are carried out using neutron diffraction and neutron scattering, light scattering, Moessbauer spectroscopy, Compton profile spectroscopy, and Auger electron spectroscopy. Studies in the field of liquid crystals are also carried out. A A-T window spectrometer was fabricated and installed at the spallation Neutron Source of the Rutherford Appleton Laboratory, U.K. The work of setting up of a 14 UD pelletron accelerator in collaboration with the Tata Institute of Fundamental Research (TIFR), Bombay is in advanced stage at TIFR. Instrumentation for DHRUVA reactor which incorporates specially designed beam tubes for neutron scattering work has been developed. Work on the development of superconducting materials and magnets is continuing. A list of papers published in journals and papers presented at conferences, symposia etc. during the year is given.

33094 **(BNL-NCS—37888) Example of nuclear data center services for geophysics applications.** Rose, P.; Burrows, T.; Tuli, J. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 8p. (CONF-8604169—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009912.

From International consultants meeting on geophysics; Vienna, Austria (7 Apr 1986).

A bibliographic survey of the available experimental data on neutron induced gamma-ray production has been made. Use was made of Data Center on-line search and retrieval capabilities. CINDA was searched for prompt gamma-ray production data covering a large incident neutron energy range, and where possible, EXFOR was used to scan the data and select representative works. From the survey it appears that many measurements will have to be supplemented by theoretical calculations. 13 refs., 2 tabs.

33095 **(CONF-860610—4-Rev.1) Neutron-photon multigroup cross sections for neutron energies ≦400 MeV. Revision 1 .** Alsmiller, R.G. Jr.; Barnes, J.M.; Drischler, J.D. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 7p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86005083.

From American Nuclear Society annual meeting; Reno, NV, USA (15 Jun 1986).

For a variety of applications, e.g., accelerator shielding design, neutrons in radiotherapy, radiation damage studies, etc., it is necessary to carry out transport calculations involving medium-energy (≧20 MeV) neutrons. A previous paper described neutron-photon multigroup cross sections in the ANISN format for neutrons from thermal to 400 MeV. In the present paper the cross-section data presented previously have been revised to make them agree with available experimental data. 7 refs., 1 fig.

33096 **(KIYI—83-34) Problems of the experimental nuclear physics.** (AN Ukrainskoj SSR, Kiev. Inst. Yadernykh Issledovanij). 1983. 19p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86780377.

Individual items in scope for the data base are processed separately.

33097 (LBL—19100, pp 4-8) **Research by accelerator users: highlights.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

Broadly, nuclear physics research at the Bevalac centers around the use of relativistic heavy-ion beams to study nuclear collisions that greatly increase the density and pressure of the nuclear matter. In one example of such research, the first clear evidence for the formation of compressed nuclear matter during heavy-ion collisions emerged from a collaboration between LBL and the Gesellschaft fuer Schwerionenforschung (GSI). In the reaction ^{93}Nb + ^{93}Nb, the particles coming from the breakup of the niobium nuclei did not scatter in random directions, but instead exhibited a collective flow that can only be explained by nuclear compression. Dense matter of this kind has been hypothesized to exist inside neutron stars, and it plays an important role in theories of the evolution of the universe. Other work focused on the high temperatures (about 100 MeV) reached in these relativistic heavy-ion collisions. In another collaboration, this one between the Institute for Nuclear Study (INS) in Tokyo and LBL, light isotope beams were produced, separated, magnetically focused, and transported to the Heavy Ion Superconducting Spectrometer. At the SuperHILAC, about half of the beam time was devoted to studies of nuclear reactions, the rest of the time going to research on nuclear structure, atomic physics, and exotic nuclei. A highlight of 1984 was the study of reverse kinematics, observed when a heavy beam impinges on a light target. Simultaneously with these programs, the biology and medicine program continued its use of heavy-ion beams in basic studies of biophysics and radiobiology and in a series of cancer-therapy trials.

33098 **(UCRL—15791) [Scattering in nuclear physics]. Final report.** Petrovich, F.L. (Florida State Univ., Tallahassee (USA)). 1986. Contract W-7405-ENG-48. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009688.

A brief summary of research activities completed by the author for the period August 1, 1985 through January 31, 1986 are presented. These activities include lectures, papers, workshops, research studies in various aspects of nuclear reactions including low energy proton and neutron reactions, a proposed medium energy neutron scattering facility, nuclear and pion scattering, nuclear potentials, and quark effects and relativistic dynamics. (DWL)

6511 Experimental Techniques

REFER ALSO TO CITATION(S) 32635

33099 **(ITEF—190(1984)) Suggestion on the measurement of excited state magnetic moments of nuclei produced in the (n,γ) reaction.** Romasheva, P.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701987.

The new technique is given for measurement of magnetic moments of nuclei isotopes, for example Ti, V, Cr nuclei, produced in excited states directly in a neutron beam as a result of the (n, γ) reaction. The technique of coincidences of magnetic field perturbed angular correlations of gamma quanta for levels with lifetime of tau $<= 10^{-10}$ c is applicable.

6512 Nuclear Properties And Reactions, A=1-5, Theoretical

33100 **(CEA-CONF—7967) Deep inelastic electron scattering on light nuclei.** Barreau, P.; Bernheim, M.; Bradu, P. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). May 1985. 10p. (CONF-850535—4; DPh-N-S—2279). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751778.

From European symposium on few-body physics - mesons and light nuclei III; Bechyne Castle, Czechoslovakia (27 May 1985).

One and two bodies nuclear currents have been explored by inclusive (ee') and exlusive (ee'p) electron scattering on ^{2}D and ^{3}He. Recoil momenta from 0 to 500 MeV/c have been measured for two or three-body break-up and compared with calculations including final state interaction and meson exchange currents. Transverse and longitudinal response functions are presented in ^{3}He between 0.1 to 0.3 $(GeV/c)^{2}$ in the quasi elastic region. 12 refs.

33101 (DOE/ER/40048—102-L4, pp 52-53) **Inclusive scattering of pions from very light nuclei at 100 MeV.** Amann, J.F.; Burger, W.; Doss, K.G.R.; Dowell, D.H.; Halpern, I.; Khandaker, H.A.; Leach, D.D.; Murakami, T.; Storm, D.W.; Tieger, D.R. (Los Alamos National Lab., NM). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Recently the authors performed an experiment on the inclusive scattering of pions from very light nuclei at 100 MeV. The experiment was motivated by their earlier finding that although inclusive pion scattering from elements heavier than ^{12}C appears to be mostly due to quasi-elastic scattering from nucleons, there are some features that cannot be accounted for in this way. The authors decided to study these features in light elements to avoid multiple scattering effects. The present measurements were carried out using the QQD spectrometer in the M11 channel at TRIUMP (Experiment 224). Data were collected for π^{+} on ^{2}H, π^{-} on ^{3}He, and $_{4}$He at 60°, 100° and 125°. For normalization and diagnostic purposes some data were also collected for ^{1}H, ^{14}N, ^{12}C, and ^{208}Pb.

33102 **(ITEF—177(1984)) Inclusive production of protons with energies of 80-240 MeV in the pHe^{4} - and π^{-} He^{4} interactions.** Alpatov, V.G.; Bayukov, Yu.D.; Vlasov, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 14p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701990.

The purpose of the present experiment has been: 1) obtaining the data on spectra of protons escaping from He^{4} nucleus induced by protons and π^{-}-mesons in the course of the same experiment in which the data for Li^{6}, Li^{7}, Be, B, C, F, Ni, Cu, Zn, Sn and In targets have been previously obtained; 2) elucidation of the contradictory situation with the relation of cumulative proton yields from He^{4} and Li^{6} nuclei. The results of measuring cross sections of inclusive production of protons with 80-240 MeV under the angles of 30 deg, 60 deg, 88 deg and 119 deg in the p^{4}He interactions at 7.5 GeV/c and π^{-}^{4}He interactions at 5 GeV/c are presented. The comparison of obtained data with the results of measuring cross sections of production of protons on other nuclei is performed.

33103 **Faddeev calculations of the 2π-3N force contribution to the ^{3}H binding energy.** Chen, C.R.; Payne, G.L.; Friar, J.L.; Gibson, B.F. (Department of Physics and Astronomy, University of Iowa, Iowa City, Iowa 52242). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 5, 1740-1752(May 1986).

The configuration-space Faddeev equations are solved for Hamiltonians that include the Tucson-Melbourne, Brazil, and Urbana two-pion-exchange three-nucleon force models. Convergence in terms of the number of three-body partial waves is demonstrated. First-order perturbation theory results are shown to be inadequate. All three models produce approximately 1.5 MeV additional binding, which overbinds the triton, when the standard value of the πN form factor cutoff is used.

6513 Nuclear Properties And Reactions, A=6-19, Theoretical

REFER ALSO TO CITATION(S) 33114

33104 **(CEA-N—2453) Elastic and inelastic scattering of 30 MeV and 180 MeV antiprotons on nuclei.** Janouin, S. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Oct 1985. 169p. (In French). NTIS (US Sales Only), PC A08/MF A01. File Number DE86751815.

This thesis reports on the first measurements of angular distributions for elastic and inelastic scattering of antiprotons from nuclei, which have been performed, using the beam delivered by LEAR and the spectrometer SPES II, over a wide angular range and with good precision. Angular distributions for elastic scattering of 50 MeV antiprotons from ^{12}C, ^{40}Ca, ^{208}Pb and 180 MeV antiprotons from ^{12}C, ^{16}O, ^{18}O, ^{40}Ca, ^{208}Pb have been measured. Data on the inelastic 4.4 MeV and 9.6 MeV excited states of ^{12}C and 1.98 MeV excited state of ^{18}O have also been collected. The diffractive angular distributions are first analysed in terms of a fuzzy black disk model, which confirms that the antiproton is strongly absorbed (annihilation) by the nuclei. Optical model analysis, with Woods-Saxon geometry, shows that the real potential is attractive and shallow. The potentials are only determined at the nuclear surface, around the strong absorption radius, where /W(R)/ > 2 / V(R)/. Main characteristics of the antip-nucleus elastic scattering cross sections are well described within microscopic models using the free elementary antiN N interaction, like KMT which have no free parameters. Possibility for test of spin-isospin dependence of the elementary amplitude antiN-N from the measurement of unnatural parity states is also studied.

33105 (DOE/ER/40048—102-L4, pp 1) **Alpha-particle cross section relevant to gamma-ray astronomy.** Bodansky, D.; Dyer, P.; Leach, D.D.; Norman, E.B.; Seamster, A.G. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The analysis of gamma-ray production cross sections for alpha-particle induced reactions on light nuclei (^{12}C, ^{14}N, and ^{16}O) is nearing completion. The cross section for production of the 4.44-MeV line in (α,α') reactions on ^{12}C is found to exceed 200 mb for incident energies from E/sub α/ = 10 MeV to the maximum energy studied, E/sub α/ = 27 MeV, and exceeds 400 mb at some points. These cross sections are somewhat greater than those for producing the 4.44-MeV line in (p,p') reactions on ^{12}C. Similarly the cross sections for the production of the 1.63-MeV and 2.31-MeV lines in (α,α') reactions on ^{14}N slightly exceed those for the corresponding (p,p') lines. The analysis of the cross sections for alpha-particle induced reactions on heavier abundant nuclei (^{20}Ne, ^{24}Mg, ^{27}Al, ^{28}Si, and ^{56}Fe) has been completed.

33106 (DOE/ER/40048—102-L4, pp 7) **Schematic model calculations of nucleon decay strengths from giant dipole resonances built on excited states.** Behr, J.A.; Snover, K.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The authors have now used the schematic model to calculate nucleon decay branching ratios to various excited states following photoexcitation of the GDR; the effects of Coulomb plus centrifugal barrier penetration have now been explicitly included. Branching ratios calculated for ground-state ^{16}O and ^{28}Si (γ,nucleon) reactions have been compared with experiment. For ^{16}O, the relative branching ratios to p/sub 3/2/ and p/1/2 neutron and proton hole states are calculated correctly within experimental error. In this case, carrier penetration effects are essential; if they are not included, the model predicts far too much p/sub 3/2/ strength. For ^{28}Si, calculated decays to eight proton hole states produce fair agreement with experiment. However, the dominant branch, proton decay to the ground state of ^{27}Al, is calculated to be a factor of two too strong, independent of the details of the calculation. This over-predicted p/sub o/ strength appears to be a clear indication of the need for a statistical component of the ground-state GDR in ^{28}Si with a relative strength (spreading width)/(total width) of about 50%.

33107 (DOE/ER/40048—102-L4, pp 8-9) **Compound nuclear isospin purity and the statistical decay of the GDR in light nuclei.** Dowell, D.H.; Feldman, G.; Harakeh, M.N.; Gossett, C.A.; Loveman, R.; Murakami, T.; Osborne, J.L.; Snover, K.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

In light self-conjugate nuclei the study of statistical excited-state GDR decays can provide a sensitive measure of compound nuclear isospin purity at moderate excitation energies. The authors made two different types of measurements of these effects in the A = 24 - 28 mass region. The first is $^{12}C + ^{16}O$ at excitation energies similar to those studied in $^{25}Mg + ^{3}He$. Here, one directly sees the effect of isospin purity in the strong inhibition of high energy γ-ray production in $^{12}C + ^{16}O$ (T=O) entrance channel) relative to $^{25}Mg + ^{3}He$ (T=O + T=1). The spectrum shape and a preliminary analysis for 40 MeV $^{12}C + ^{16}O$ are shown. For E/sub γ/ > 13 MeV the yield comes mainly from the initial compound nucleus and is much less than the mixed isospin limit. However, the measured yield is somewhat larger than the pure-isospin calculation, requiring about 3% isospin mixing in the initial compound nucleus. This is about five times less than other experiments have indicated for lower excitation energies. The second type of measurement consists of comparing $^{12}C + ^{12}C$, $^{12}C + ^{13}C$ and $^{13}C + ^{13}C$ reaction yields. The latter two reactions lead to N is not equal to Z compound nuclei and hence have normal γ-ray yields, whereas high energy γ-ray yields from $^{12}C + ^{12}C$ are again observed to be strongly inhibited.

33108 (DOE/ER/40048—102-L4, pp 22) **Nuclear rainbow scattering with carbon isotopes.** Bohlen, H.G.; Cramer, J.G.; Gebauer, B.; Michachaka, H.; von Oertzen, W.; Xueshi, C. (Hahn-Meitner-Institute fuer Kernforschung, Berlin, West Germany). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The phenomenon of nuclear rainbow scattering or far-side scattering observed in elastic scattering with projectiles of Z = 1 - 3 has provided valuable insights into interaction potentials and light ion reaction mechanisms. Until recently there had been no evidence that projectiles with Z > 3 could exhibit such nuclear-rainbow/far-side scattering effects. However, within the past two years groups at CERN and at the Hahn-Meitner Institute have observed the clear signature of this phenomenon in $^{12}C + ^{12}C$ scattering at laboratory bombarding energies above about 20 MeV/nucleon. It is therefore of considerable interest to determine if heavier systems can also show nuclear rainbow scattering effects. Using the VICKSI accelerator system at the Hahn-Meitner Institute the authors have investigated this question for the systems $^{12}C + ^{16}O$, $^{13}C + ^{12}C$, and $^{13}C + ^{14}C$ with a ^{13}C beam at 22 and 25 MeV/nucleon and ^{13}C beam at 18 and 22 MeV/nucleon. Preliminary analysis indicates that the ^{13}C + /sup 12-14/C systems show clear nuclear-rainbow/farside effects while the $^{12}C + ^{16}O$ system shows little evidence of this phenomenon.

33109 (DOE/ER/40048—102-L4, pp 23-24) **Penetrability of the centrifugal barrier and the spin distribution of the compound nucleus.** Abriola, D.; DeYoung, P.; Gil, S.; Lazzarini, A.; Lock, D.K.; McGrath, R.; Ray, A.; Vandenbosch, R. (State Univ. of New York, Stony Brook). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The authors have continued their studies of the penetrability of the centrifugal barrier and its effect on the spin distribution of the compound nucleus in heavy ion collisions. This year they have performed a series of experiments to measure the total fusion cross section and the first moment of the gamma ray multiplicity M/sub γ/ utilizing an experimental technique previously described. The authors used the systems: α, ^{12}C, ^{16}O and ^{28}Si on ^{154}Sm.

33110 (DOE/ER/40048—102-L4, pp 27) **New scheme for the calibration of sub-Coulomb heavy ion proton transfer reactions.** Davis, K.J.; Lazzarini, A.; Murakami, T. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

A triad of proton transfer reactions can be used to isolate the product of a spectroscopic factor and the square of the radial wave function for the exchanged proton in the initial and final configurations. Such a set of reactions was described in last year's Annual Report. Only one of those reactions proved to be feasible, so a new triad is being investigated: $^{42}Ca + ^{15}N \rightarrow ^{41}K + ^{16}O$, $^{40}Ca + ^{27}Al \rightarrow ^{41}K + ^{28}Si$ and $^{27}Al + ^{16}O \rightarrow ^{28}Si + ^{15}N$. In each case the authors are planning to use the heavier nucleus as the projectile. They have performed beam development work with the sputter source and have achieved an 80 nA beam of ^{27}Al 6+ after energy analysis and a 52 nA beam of ^{40}Ca 8+. The authors expect similar results when isotopically enriched ^{42}Ca is used in the source.

33111 (DOE/ER/40048—102-L4, pp 31-32) **Reactions of ^{24}Mg with ^{16}O.** Gil, S.; Khandaker, M.A.; Leach, D.D.; Lock, D.K.; Ray, A.; Vandenbosch, R. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The authors have recently performed an experiment to measure the angular distribution of the oxygen and carbon particles from the $^{16}O(^{24}Mg,^{16}O)^{24}Mg$ and $^{16}O(^{24}Mg,^{12}C)^{28}Si$ reactions at E/sub Lab/ = 79.5 MeV at back angles. The motivation for this measurement is to find out whether the large inelastic cross sections observed at backward angles in the carbon and oxygen channels in the $^{28}Si + ^{12}C$ reaction are due to a compound nuclear process. The authors form a ^{40}Ca nucleus by the $^{24}Mg + ^{16}O$ reaction at the same excitation energy and approximately the same angular momentum (within 5%) as for the $^{28}Si + ^{12}C$ reaction and compare the relative intensities of the carbon and oxygen yields. If they see an entrance-channel effect, then the back-angle yields cannot be attributed to a compound nuclear process.

33112 (DOE/ER/40048—102-L4, pp 36-38) **Theory of the ^{14}N parity mixing measurement.** Adelberger, E.G.; Brown, B.A.; Hoodbhoy, P. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The general principles of our experiment to measure the $\Delta I = 0$ parity mixing between the I = 1 O^+ and O^- levels at E/sub X/ = 8.618 and 8.79 MeV in ^{14}N were given in last year's Annual Report. A paper, to appear in Phys. Rev. C, develops the formalism of longitudinal analyzing power (A/sub L/) measurements over parity mixed resonances and applies this to the example of probing the parity mixing in ^{14}N by detecting A/sub L/ over the narrow O^+ resonance. The formalism utilizes the single-level approximation to Bloch's formulation of reaction theory in order to account for the strong (parity-conserving) reaction amplitudes and is restricted to parity nonconservation associated with the closeness of the two opposite parity resonances. An example of the parity conserving

calculation is shown where we compare our calculation to existing unpolarized $^{13}C(p,p)$ data. In order to determine the widths and separation of the O^+ and O^- resonances the authors studied the $^{13}C(p,\gamma/sub\ o/)$ reaction at THETA/sub lab/ = 90°. Results are shown.

33113 (DOE/ER/40048—102-L4, pp 59-60) **Lifetime and magnetic moments of states of ^{16}N by the recoil-into-vacuum method.** Hanna, S.S.; Neyer, B.T.; Thornton, J.L. (Stanford Univ., CA). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Lifetime and moment measurements were made on the 297 keV, 3_1^- state in ^{16}N and lifetime measurements were made on the 397 keV, 1^{1-} state in ^{16}N, with the reaction $d(^{15}N,p)^{16}N$. Measurements detecting the outgoing coincidence proton were made at a beam energy of 34 MeV, while singles measurements were performed at 20 MeV. The preliminary results obtained are shown.

33114 (INP—1191/PL) **Two-step direct processes in the $^{12}C+^9Be$ system.** Kamys, B. (Institute of Nuclear Physics, Krakow (Poland)). 1982. 64p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86701991.

Angular and energy dependence of the cross-sections were studied for two-step direct processes in the $^{12}C+^9Be$ system. The theoretical analysis was performed by means of the exact finite range coupled-reaction-channels (CRC) calculations including the compound nucleus background. A consistent analysis of the elastic scattering, inelastic scattering and (^9Be,^9Be) reactions enabled to obtain absolute (parameter free) values of the two-step cross-sections. It was shown that two-step processes are responsible for non-negligible component of the cross-sections and their neglect may in many cases lead to qualitative and quantitative disagreement of the theory and experimental data.

33115 (JINR—E-4-85-311) **Spin-dipole excitations of ^6Li in charged pion photoproduction.** Eramzhyan, R.A.; Kaipov, T.D.; Kamalov, S.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics; Kazakhskij Gosudarstvennyj Univ., Alma-Ata (USSR)). 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701982.

Submitted to the journal Z. fur Phys. .

In the framework of bound shell model the photoproduction cross sections of charged pions on ^6Li are calculated when spin-isospin dipole resonance is excited. It is shown that the transition strength concentrates in several energy regions. Such a gross-structure of the excitation spectrum is governed by the configurational splitting of the resonance. The excitation spectrum in $^6Li(\gamma,\pi)$-reaction is compared with the $^6Li(\pi,\gamma)$, (e, e') and (n, p) reaction spectra where spin-isospin transitions are also dominating.

33116 (JINR—R-4-85-319) **Study on the ^{12}C structure and theoretical description of nucleus-nucleus scattering.** Kaschiev, M.; Saupe, G.; Shitikova, K.V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics; Moskovskij Gosudarstvennyj Univ. (USSR). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki). 1985. 14p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701973.

Submitted to the journal J. Phys. .

The structure of different excited states of the ^{12}C nucleus has been investigated in the framework of the hyperspherical function method. The spectrum of excited 0^+- and 2^+-states up to E * = 22 MeV, the corresponding density distributions, rms-radii and reduced probability B(E2)-values have been calculated. Then, folding-potentials have been constructed and used for the description of elastic and inelastic scattering of light ions by ^{12}C.

33117 **P-C analyzing power between 100 and 750 MeV.** McNaughton, M.W.; Bonner, B.E.; Ohnuma, H.; Van Dijk, O.B.; Sun Tsuhsun; Hollas, C.L.; Cremans, D.J.; McNaughton, K.H.; Riley, P.J.; Rodebaugh, R.F. (Los Alamos National Lab., NM, USA; Texas Univ., Austin, USA; Rice Univ., Houston, TX, USA). *Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors, and Associated Equipment;* **241**: No. 2/3, 435-440(1 Dec 1985).

The inclusive p-C analyzing power has been measured for laboratory scattering angles between 3° and 19° for energies between 80 and 584 MeV. The experiment was performed at LAMPF using a large solid angle polarimeter. These data have been incorporated into the existing data base to obtain a new energy dependent p-C analyzing power fit for the energy range 100-750 MeV.

33118 **Neutron scattering cross sections from ^{14}N and ^9Be at 11, 14, and 17 MeV.** Templon, J.A.; Dave, J.H.; Gould, C.R.; Singkarat, S. (North Carolina State University, Raleigh, NC). *Nuclear Science and Engineering;* **91**: No. 4, 451-457(Dec 1985).

Neutron scattering cross sections were measured for ^{14}N and ^9Be at incident neutron energies of 11, 14, and 17 MeV using time-of-flight methods. Angular distributions for ^{14}N and ^9Be elastic scattering and ^9Be inelastic scattering to the 2.429-MeV excited state were obtained betwee 20 and 160 deg in 5-deg increments. The data were corrected for finite geometry effects using a Monte Carlo simulation code. Lengendre polynomial coefficients deduced by fitting the experimental data are tabulated. The results of a spherical optical model analysis for the ^{14}N data are reported. Coulomb correction terms are obtained from a comparison of neutron and proton elastic scattering data for ^{14}N.

6514 Nuclear Properties And Reactions, A=20-38, Theoretical

33119 (CEA-N—2447) **Excitation functions of ^{58}Ni, ^{60}Ni, ^{62}Ni compound nuclei formed via symmetric and asysmetric entrance channels.** Bozek, E.; Castro Rizzo, D. de; Cavallaro, S.; Delaunay, B.; Delaunay, J.; Dumont, H.; d'Onofrio, A.; Saint-Laurent, M.G.; Sperduto, L.; Terrasi, F. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Sep 1985. 54p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751813.

Excitation function for the residue of the systems ^{12}C + ^{46}Ti - > ^{58}Ni, ^{28}Si + ^{30}Si → ^{58}Ni, ^{12}C + ^{48}Ti → ^{60}Ni, ^{30}Si + ^{30}Si → ^{60}Ni, ^{12}C + ^{50}Ti → ^{62}Ni, ^{18}O + ^{44}Ca → ^{62}Ni were measured at energies approximately 0.7 to 1.6 times the Coulomb barrier. These experimental values were compared with the predictions of the fusion-evaporation.

33120 (DOE/ER/40048—102-L4, pp 5-6) **β^+ decays of ^{34}Ar, ^{34}Cl and ^{38}K.** Adelberger, E.G.; Osborne, J.L.; Swanson, H.E.; Zeps, V.J. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The authors have performed a series of preliminary experiments using the gas-transfer system to investigate the feasibility of measuring weak branches in the β^+ decays of ^{34}Ar, ^{34}Cl and ^{38}K. As in previous experiments, the activities of interest were produced by bombarding a gas target and transporting the gas to a well-shielded counting station where the decay γ rays were counted by a large GeLi detector. A 2.5-cm lead hardener was placed in front of the detector to reduce the counting rate of annihilation radiation relative to the more energetic beta-delayed γ rays. The 0.845s ^{34}Ar activity was produced by the $^{32}S(^3He,n)$ reaction on H_2S gas at a bombarding energy of 14.5 MeV. At the same time, the 1.526s positron decay of the daughter nucleus, ^{34}Cl was also investigated. The 3^+ ground state of ^{38}K and its O^+ isomer, the analogue of the ground state of ^{38}Ar, were produced by the reaction $^{35}Cl(\alpha,n)$ at a bombarding energy of 11 MeV, using Freon-11 ($CFCl_3$) as the target gas.

33121 (DOE/ER/40048—102-L4, pp 26-27) **Search for high spin states in ^{32}S.** Davis, K.J.; Gil, S.; Hindi, M.; Lazzarini, A.; Lesko, K.T.; Lock, D.K.; Murakami, T.; Ray, A.; Vandenbosch, R. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Continuing their effort to locate the higher members of the yrast line in ^{32}S, this year the authors have performed a series of experiments in order to locate the particle unbound members of the band by using a particle-particle coincidence method. Summarizing the results of studies of ^{32}S, through a particle-gamma coincidence experiment reported previously they have been able to detect the gamma-decay properties of four levels at E/sub X/ = 6.763, 7.46, 8.3 and 8.5 MeV. The E/sub X/ = 6.763 MeV level was assigned J/sup π/ = 5$^-$, E/sub X/ = 7.46 MeV J/sup π/ = (1$^-$,2$^+$), E/sub X/ = 8.3 MeV J/sup π/ = (6$^+$) and E/sub X/ = 8.508 MeV J/sup π/ = (3$^-$,2$^+$). Two α-unbound levels at E/sub Z/ = 11.0(+/-0.4) MeV and 12.5(+/-0.4) MeV are strongly populated with the reaction ^{28}Si(^{16}O, ^{12}C)^{32}S at E/sub lab/ ~ 70 MeV, with an appreciable branching ratio for decay to ^{28}Si(g.s.). The experiment did not yield a definite spin assignment for them, but suggests overlapping levels or low spin values (J/sub π/ $\leqq$ 5).

33122 (ISN—85-12) **Survivance of complete fusion for the ^{14}N+^{27}Al system.** Guinet, D.; Billerey, R.; Cerruti, C.; Chiodelli, S.; Demeyer, A.; Zaid, K.; Kox, S.; Natowitz, J.B.; Namboodiri, M.N. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). 1985. 1p. (CONF-850672—17-Summ.). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751809.

From 2. international conference on nucleus-nucleus collisions; Visby, Sweden (10 Jun 1985).

Published in summary form only.

33123 **Search for "subthreshold" production of antiprotons and creation of fractional charges and new particles in relativistic nuclear collisions.** Abachi, S.; Shor, A.; Barasch, E.; Carroll, J.; Fisher, P.; Ganezer, K.; Igo, G.; Mulera, T.; Perez-Mendez, V.; Trentalange, S. (University of California, Los Angeles, California 90024; Lawrence Berkeley Laboratory, Berkeley, California 94720; University of California, Davis, California 95616). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 9, 2733-2736(1 May 1986). Contract AC03-76SF00098;AC03-76SF00515.

A search for "subthreshold" production of antiprotons and creation of fractional charges and new particles at 0^0 in the reaction ^{28}Si+ ^{28}Si at 2.1 GeV/nucleon has been made at six secondary rigidities. Except for one p-bar candidate, no evidence for such production is found. A summary of upper limits on the yields for charges -(1/3), -(2/3), -1, -(4/3), and -2 is presented. The results from all six rigidities are combined to yield upper limits of less than 1 particle per 10^4 to 10^7 collisions for the mass range 0.1<M<5.0 GeV, and less than one p-bar per 3.8 x 10^7 collisions.

6515 Nuclear Properties And Reactions, A=39-58, Theoretical

33124 (CEA-CONF—8060) **Longitudinal-transverse separations in coincidence experiments.** Morgenstern, J.J. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jul 1985. 6p. (CONF-850702—5; DPh-N-S—2306). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751781.

From 11. Europhysics conference on nuclear physics with electromagnetic probes; Paris, France (1 Jul 1985).

Longitudinal and transverse separation have been performed in ^{40}Ca(e,e'p)^{39}K reaction for three kinematics around <psub(R)> = 52, 121, 146 MeV/c. A ratio σsub(L)/σsub(T) equal to approximately 42% of the free proton one was observed and compared to non-relativistic (for the proton-nucleus interaction) off-mass shell calculations, and to relativistic models calculations.

33125 (CONF-860396—7) **Experimental overview of subbarrier fusion.** Beckerman, M. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010017.

From Symposium on the many facets of heavy ion fusion reactions; Argonne, IL, USA (24 Mar 1986).

The structural variations of heavy nuclei are highlighted and how these variations correlate with simple many-body properties such as quadrupole moments and transfer Q-values. Dramatic effects occurring near closed-shells are also examined. 62 refs., 19 figs., 2 tabs. (DWL)

33126 (DOE/ER/40048—102-L4, pp 10-11) **Statistical GDR decays in ^{16}O + Ni for various Ni isotopes.** Garman, E.F.; Gundlach, J.; Feldman, G.; Harakeh, M.N.; Behr, J.A.; Osborne, J.L.; Snover, K.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

In addition to studying ^{63}Cu* decays over a wide excitation energy range, as described in the preceding section of this report, the authors are also examining the inclusive γ-ray production cross section for ^{16}O + /sup x/Ni - induced reactions over a wide range of nickel isotope number (x = 58 to 64). Results have been obtained to date for 60-MeV ^{16}O + /sup 58,61,64/Ni. Preliminary Cascade fits to the ^{61}Ni and ^{64}Ne data indicate similar GDR parameters: GDR resonance energies E/sub G/ = 15.5 MeV, widths GAMMA = 5.5 MeV and strengths S/sub El = 0.33 in units of the classical dipole sum rule.

33127 (DOE/ER/40048—102-L4, pp 11-12) **Study of excited-state GDR's in 1f-2p shell nuclei.** Behr, J.A.; Dowell, D.H.; Feldman, G.; Garman, E.F.; Gossett, C.A.; Gundlach, J.; Harakeh, M.N.; Loveman, R.A.; Osborne, J.L.; Snover, K.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

An earlier study of the ^{27}Al(p,γ)^{28}Si reaction revealed a series of GDR's built upon excited states in ^{28}Si up to E/sub x// sup f/ = 14.36 MeV. The authors are continuing their investigation of the properties of excited-state GDR's by studying (p,γ) reactions in the f/sub 7/2/ nuclei (A = 45-6-). Our emphasis is on understanding how the (p,γ) GDR capture strength is related to the single-proton stripping spectroscopic factors C^{2}S$^+$ for states in these nuclei up to E/sub x//sup f/ = 8 MeV. The authors will also study statistical γ-ray spectra from heavy-ion fusion reactions forming the same compound system to determine the extent to which the observed (p,γ) strength comes from statistical decay of a thermally equilibrated compound nucleus. Several targets in the f/sub 7/2/ shell were chosen to yield a combined system with interesting C^{2}S$^+$ distributions below 10 MeV, including strong, resolvable states. Data have already been obtained for the ^{43}Sc(p,γ)^{44}Ti* and ^{51}V(p,γ)^{52}Cr* reactions from E/sub p/ = 4-15 MeV (E/sub x/ = 14-25 MeV) at THETA/sub γ/ = 90^0, in addition to five-point angular distributions for E/sub p/ = 7, 11, 15 MeV. The statistical reaction ^{46}Ti(α,γ)^{50}Cr* has also been studied at E/sub α/ = 24 and 17.2 MeV (E/sub X/ = 32 and 25 MeV). Results indicate that the γ-ray strength distribution does in fact correspond qualitatively with the proton stripping strength.

33128 (DOE/ER/40048—102-L4, pp 14-16) **Excited-state giant resonances observed in the ^{39}K(p,γ)^{40}Ca and ^{40}Ca(p, γ)^{41}Sc reactions.** Dowell, D.H.; Gossett, C.A.; Ricken, L.; Sandorfi, A.M.; Snover, K.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The authors have measured ^{39}K(p, γ)^{40}Ca and ^{40}Ca (p,γ)^{41}Sc cross sections at THETA/sub γ/ = 90^0 for E/sub p/ = 10-36 MeV using the two-stage and three-stage tandem accelerators at Brookhaven National Laboratory. Sample gamma-ray spectra for ^{39}K(p,γ)^{40}Ca at E/sub p/ = 18 MeV and for ^{40}Ca(p,γ)^{41}Sc at E/sub p/ = 25 MeV are shown. Also illustrated are the proton stripping spectroscopic factors, C^{2}S/sub p/$^+$. Strong correlation between the structure in the (p,γ) cross section and the distribution of stripping strength is observed. Evidence of a large concentration of single-particle strength at E/sub X//sup f/ ~ 9.6 MeV not previously observed in proton stripping is seen in the ^{39}K(p,γ)^{40}Ca data. The authors also find a broad concentration of strength near E/sub X//sup f/ ~ 14.5 MeV in ^{40}Ca. The authors observe structure in

the final-state single-particle strength distribution in the $^{40}Ca(p,\gamma)^{41}Sc$ reaction up to E/sub X//sup f/ ~ 10 MeV, and evidence for excited-state GDR's built upon broad distributions of single-particle strength in ^{41}Sc up to E/sub X//sup f/ ~ 23 MeV.

33129 (DOE/ER/40048—102-L4, pp 17-20) **Determination of a time scale for the emission of high energy photons in heavy ion fusion reactions.** Habs, D.; Hennerici, W.; Kroth, R.; Lazzarini, A.; Metag, V.; Schirmer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg, West Germany). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The measurement was performed with an 80 MeV ^{16}O pulsed beam from the MPI Heidelberg Tandem Van de Graaff Facility, by bombarding a 400 $^{+}g/cm^{2}$ isotopically enriched ^{56}Ni target. Coincidences were detected between the MPI-GSI 4π Crystal Ball Spectrometer and an array of 4 ΔE-E surface barrier telescopes positioned at angles THETA/sub lab/ = 90°, 120°, 160°, each with typical solid angle ΔOMEGA = 40 msr. 159 of the 162 NaI(Tl) detectors of the Crystal Ball were employed. Once the Crystal Ball trigger was registered, all coincident NaI(Tl) detectors were accepted. Particle energy and angular distributions in coincidence with γ rays detected with the MPI-GSI 4π γ-ray spectrometer were measured, along with γ multiplicity and angular correlations. From the particle energy spectra it is possible to estimate the time at which high energy photons are emitted during the compound-nuclear decay. In addition, the multiplicities of both charged particles and γ rays yield information from which details about the spin distribution in the compound nucleus responsible for the energetic photons could be deduced.

33130 (DOE/ER/40048—102-L4, pp 34-35) **Effect of particle evaporation in the $^{136}Xe + ^{56}Fe$ reaction and a reinvestigation of the $^{86}Kr + ^{92}Mo$ system.** Gil, S.; Lazzarini, A.; Leach, D.D.; Lesko, K.T.; Lock, D.K.; Vandenbosch, R.; Seamster, A.G. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The nuclide distributions of Fe-like reaction products from 5.9 MeV/n ^{136}Xe on ^{56}Fe were measured as a function of excitation energy at a laboratory angle of 55.5° using the time-of-flight technique. From the measured distribution of yields the first and second moments were obtained in addition to the correlation coefficients and the isobaric variances. These results were compared with evaporation calculation. The comparison between our data and the results of the evaporation calculation shows that our data can be better described by the nucleon exchange model with the inclusion of the effect of particle evaporation. The isobaric variances were measured for the 430 MeV $^{86}Kr + ^{92}Mo$ system at 39° in the laboratory using the time-of-flight technique. Our measured variances are smaller than those obtained by Berlanger et al. at low energy losses and are in agreement with the results from the nucleon exchange model.

33131 (DOE/ER/70035—7, pp 38-42) **Radiochemical studies of unusual projectile fragments.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

In last year's Annual Report, we reported the first results of the experimental program of R. Brandt and co-workers to study the interaction of projectile fragments in copper using radioactivation techniques. (Our role has been to assist Brandt et al. in making their irradiations and measurements at the LBL Bevalac). In this experiment, two identical copper blocks, 1 cm thick and 8 cm in diameter, are irradiated by relativistic projectiles in different configurations. In configuration O, the blocks are touching while in configuration 10 or 20, the blocks are separated by 10 or 20 cm of air, respectively. It is assumed that when the relativistic projectiles interact with the first block of each pair, projectile fragments are created which interact with other nuclei in the first and second blocks. What is measured is the ratio of some target fragment activity, such as ^{24}Na or ^{28}Mg, produced in the second block relative to the first block, R. The values of R that were measured for different target fragments produced in the interaction of 0.9 and 1.8 GeV/A ^{40}Ar with Cu (two runs at each energy) are shown.

33132 (GANIL-P—85-10) **Light particle correlations in Ar + Au reaction at 60 MeV/A.** Ardouin, D.; Delagrange, H.; Doubre, H. (Grand Accelerateur National d'Ions Lourds (GANIL), 14 - Caen (France)). Jun 1985. 6p. (CONF-850672—15). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751807.

From 2. international conference on nucleus-nucleus collisions; Visby, Sweden (10 Jun 1985).

In intermediate-energy heavy ion collisions, particle emission prior to full statistical equilibrium is expected to provide information about the thermodynamic properties of excited nuclear matter. The question of statistical equilibrium is obviously related to the interplay between collective and two-body processes. We present in this contribution measurements of particle-particle correlations at large relative momenta to look for finger-prints of the two processes; correlations at small relative momenta which could give information about the stage when the system goes out of (local) equilibrium are also presented.

33133 (ITEP—123(1984)) **Kinetic energy flow analysis of high-energy heavy-ion collisions. Classical equations-of-motion approach.** Kiselev, S.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1984. 18p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701980.

For the Ne+U, Nb+Nb 400 MeV/nucleon and Ca+Ca 800 MeV/nucleon reactions the results of kinetic energy flow analysis carried out on the basis of classical equations-of-motion model are presented. The model describes the global values of the events and the side-splash effect observed in the experimental well. The flow angle turned out to be quite sensitive to the model effective NN potential which parametrizes the compression dynamics. This allowed to estimate the characteristics of compression zone forming in the collision process.

6516 Nuclear Properties And Reactions, A=59-89, Theoretical

33134 (DOE/ER/40048—102-L4, pp 9-10) **Statistical GDR decays over a wide range of energy from the $^{63}Cu^{*}$ compound nucleus.** Garman, E.F.; Gundlach, J.; Feldman, G.; Harakeh, M.N.; Behr, J.A.; Osborne, J.L.; Snover, K.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

As a follow-up investigation of statistical GDR emission from highly excited states in medium mass nuclei, the authors have made a study of $^{63}Cu^{*}$ over a wide range of excitation energy. The authors have formed this compound nucleus via $\alpha + ^{59}Co$ for a range of different initial excitation energies E/sub X/ = 16.9 to 28.2 MeV, via $^{12}C + ^{51}V$ for E/sub X/ = 34.7 to 52.3 MeV.

33135 (ISN—85-11) **Competing mechanisms in the $^{40}Ar + ^{68}Zn$ reaction between 10 and 30 MeV/nucleon.** Guillaume, G.; Rami, F.; Coffin, J.P.; Fahli, A.; Heusch, B.; Jundt, F.; Cole, A.J.; Kox, S. (Grenoble-1 Univ., 38 (France). Inst. des Sciences Nucleaires). 1985. 1p. (CONF-850672—16-Summ.). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751808.

From 2. international conference on nucleus-nucleus collisions; Visby, Sweden (10 Jun 1985).

Published in summary form only.

33136 **Electromagnetic dissociation of ^{59}Co, ^{89}Y, and ^{197}Au targets by relativistic heavy ions to Z = 26.** Mercier, M.T.; Hill, J.C.; Wohn, F.K.; McCullough, C.M.; Nieland, M.E.; Winger, J.A.; Howard, C.B.; Renwick, S.; Matheis, D.K.; Smith, A.R. (Ames Laboratory and Iowa State University, Ames, Iowa 50011). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 5, 1655-1667(May 1986).

The electromagnetic dissociation of ^{59}Co, ^{89}Y, and ^{197}Au target nuclei was inferred from measurements of cross sections for the one-neutron removal reaction. Beams of 2.1 GeV/nucleon ^{1}H, ^{12}C, and ^{20}Ne, 1.8 GeV/nucleon ^{40}Ar, and 1.7 GeV/nucleon ^{56}Fe

projectiles were used. Beam intensities were monitored using the $^{12}C(RHI,X)^{11}C$ reaction, where RHI represents relativistic heavy ion beams. The experimental cross sections in excess of the estimated nuclear contributions are generally well described by use of the Weizsaaumlcker-Williams method for calculating the electromagnetic dissociation contributions but increase more slowly as the projectile charge is increased. Cross sections for one-neutron removal reactions are large for the heavier projectiles, ranging up to 707 mb. For these cases a high percentage is from the electromagnetic dissociation process.

6517 Nuclear Properties And Reactions, A=90-149, Theoretical

REFER ALSO TO CITATION(S) 33133

33137 (DOE/ER/40048—21-N6) **Molybdenum solar neutrino experiment.** Haxton, W.; Cowan, G.A.; Wolfsberg, K.; Schroeder, N.C.; Rokop, D.J.; Cappis, J.H.; Curtis, D.B. (Washington Univ., Seattle (USA). Inst. for Nuclear Theory; Los Alamos National Lab., NM (USA)). 1986. Contract AC06-81ER40048. 5p. (CONF-860167—5). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010451.

From Recontres de Moriond workshop on massive neutrinos in particle physics and astrophysics; Tignes, Savoie, France (25 Jan 1986).

The present status of the molybdenum solar neutrino experiment is described. 9 refs.

33138 (DOE/ER/40048—102-L4, pp 2) **Searches for $\beta^+\beta^+$, β^+/EC and EC/EC decays.** Nelson, M.A.; Normon, E.B. Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

As described in last year's Annual Report, the authors have begun a search for $\beta^+\beta^+$, β^+/EC, and EC/EC decays using a 4π NaI detector system. In an attempt to reduce the background counting rate due to cosmic rays, the authors installed a large plastic scintillator veto paddle above the detector. However, this was found to produce no observable decrease in the background rate. Thus it appears that the origin of this background must be radioactive impurities in the detector itself and in the shielding material. For the immediate future, in order to obtain greater sensitivity for detecting $\beta^+\beta^+$, β^+/EC, and EC/EC decays the authors simply plan to count for long periods of time.

33139 (DOE/ER/40048—102-L4, pp 3) **Search for ^{92}Nb in nature.** Norman, E.B. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Apt et al. have reported the observation of the t/sub 1/2/ = 3.5 x 10^7 year ^{92}Nb in a sample of natural niobium. Although the inferred abundance ratio of ^{92}Nb/^{93}Nb is only 2 x 10^{-13}, it is far larger than can be accounted for by any conventional nucleosynthetic process. Because of the difficulty in accounting for the presence of ^{92}Nb in terrestrial material, it was felt that a remeasurement of ^{92}Nb abundance should be performed. To do so, two ~1 kg samples of Nb were acquired. Using the 4π NaI detector system at the UW Laboratory for Radiation Ecology, searches are currently being made for the 561- and 935-keV γ rays known to be emitted in the decay of ^{92}Nb. To date, no positive evidence of these two γ rays has been observed.

33140 (DOE/ER/40048—102-L4, pp 13-14) **Deformation effects in the statistical decay of the giant dipole resonance.** Behr, J.A.; Feldman, G.; Gossett, C.A.; Murakami, T.; Osborne, J.L.; Snover, K.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

A measure of the effects of deformation on excited-state GDR's is obtained by comparing the gamma-ray yields from reactions in which the compound nucleus has low-lying levels which are highly deformed with those in which the compound nucleus has low lying levels which have little or no deformation. In particular, the authors have studied ^{12}C + ^{148}Sm and ^{12}C + ^{154}Sm for a ^{12}C incident energy of 63 MeV, in addition to α + ^{148}Sm and α + ^{154}Sm for E/sub α/ = 24 and 27 MeV. A comparison of the gamma-ray spectra measured at THETA/sub γ/ = 90^0 for the alpha induced reactions is shown. The additional structure observed in the high energy gamma yield for the α + ^{154}Sm reaction when compared to α + ^{148}Sm provides evidence of the splitting of the GDR strength function due to nuclear deformation at elevated nuclear temperatures. Results for the spectral shapes from the ^{12}C + ^{148}Sm and ^{12}C + ^{154}Sm reactions are currently being analyzed. Statistical model calculations from the code Cascade will be compared with the data in order to extract the energy, width and strength parameters for the GDR strength functions. These parameters will then provide quantitative information about the average deformation of excited states in the compound nucleus.

33141 (DOE/ER/40048—102-L4, pp 60-62) **Simultaneous measurement of nuclear magnetic moments by the transient field method.** Hanna, S.S.; Neyer, B.T.; Thornton, J.L. (Stanford Univ., CA). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

In the past year the authors have completed measurements of the magnetic moments of the first 2^+ states in all even Pd and Te isotopes except ^{130}Te, which was not measured because of its small counting rate. The primary goal of these experiments has been to determine deviations from the predictions of the collective model, g = Z/A. Of particular interest was the exact dependence of the magnetic moments on neutron number N and whether this dependence agreed with predictions of the Interacting Boson Approximation (IBA) and with some previous data. In this regard special emphasis was placed on modifying the usual transient field method in order to obtain much reduced systematic errors. In this modified method several isotopes were measured at once, instead of the usual one per target and the resulting γ ray lines were separated with Ge(Li) detectors instead of being observed in NaI detectors. Due to the increased resolution of the Ge(Li) detectors this procedure results in a much cleaner extraction of the angular rotations from the data. In addition target dependent errors are virtually eliminated since now beam damage or target fabrication uncertainties will affect all the isotopes equally.

33142 (DOE/ER/70035—7, pp 18-19) **Complete and incomplete fusion studies at intermediate energies. Part II.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

We have undertaken to measure the yields and differential ranges of evaporation residues from the reaction of 315 MeV ^{16}O, 420, 588 MeV ^{12}C, and 1760 MeV ^{40}Ar with the neutron-deficient rare earths ^{143}Nd and ^{144}Sm. The results of these investigations are to be compared with one another and the results of similar studies with the neutron-rich rare earths, ^{160}, ^{154}Sm and ^{176}Yb. Measurements of the yields and differential range spectra were made for all of the above systems during the past year. Data analysis is in progress for all studies except the ^{40}Ar induced reaction where data collection continues. The first preliminary results from the interaction of 315 MeV ^{16}O with ^{143}Nd show the yield distributions to be shifted to lower atomic numbers (by ~ 3 Z units) relative to the (N,Z) of the target when compared to the results of the 315 MeV ^{16}O + ^{154}Sm study. The velocity spectra for typical, most probable products in the $_{\ }^{143}$Nd reaction show substantially smaller velocities when compared to the most probable products from the ^{154}Sm reaction.

33143 (DOE/ER/70035—7, pp 26-29) **La target fragmentation induced by high energy La and U ions.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

As an extension of previous studies and as our first attempt to use the ultraheavy high energy beams available from the LBL Bevalac, we measured the target fragment yield distribution from the interaction of 400 MeV/A ^{238}U with ^{139}La. Multiple La targets of thickness ~ 380 mg/cm^2 were irradiated with a 400 MeV/A ^{139}La beam of intensity ~ 5 x 10^5 ions/min for 29 hours. The fission cross section, as represented by fragments with 50 ≦ A ≦ 80,

appears to be similar to that observed in the La + La reaction with increased yields for near-target and spallation products being observed in the U + La reaction. Comparison of these data with models for target fragmentation should prove interesting.

33144 **Identification and decay of neutron-rich ^{102}Sr and level structure of A~100 Y nuclei.** Hill, J.C.; Winger, J.A.; Wohn, F.K.; Petry, R.F.; Goulden, J.D.; Gill, R.L.; Piotrowski, A.; Mach, H. (Ames Laboratory, Ames, Iowa; Iowa State University, Ames, Iowa 50011). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 5, 1727-1735(May 1986). Contract W-7405-ENG-82;AC02-76CH00016.

The previously unreported decay of ^{103}Sr to levels in ^{103}Y has been studied from mass-separated activity produced in the thermal neutron fission of ^{235}U. A half-life for ^{102}Sr was measured to be 68 +- 8 ms. Based on γ singles and coincidence measurements, 24 γ rays were placed in a level scheme for ^{103}Y with nine excited states up to 1689 keV. Four excited states were assigned a J/sup π/ of 1^+ from logft values. Evidence for delayed-neutron emission from ^{102}Sr is reported. These results are compared with systematics for other neighboring, highly deformed, odd-odd Y and Nb nuclei. The level structure of A~100 Y nuclei, which exhibit a very abrupt transition from spherical to highly deformed shapes, is reviewed. The possibility of the existence of bands with moments of inertia close to that of a rigid rotor is discussed.

33145 **Evidence for a coexisting four-particle, four-hole band in doubly closed subshell ^{96}Zr.** Molnar, G.; Yates, S.W.; Meyer, R.A. (Institute of Isotopes, Hungarian Academy of Sciences, H-1525 Budapest, Hungary). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 5, 1843-1846(May 1986). Contract W-7405-ENG-48.

The occurence of a coexisting four-particle, four-hole band built on the first excited 0^+ state in the doubly closed subshell nucleus ^{96}Zr is established from (n,n'γ) reaction experiments and previous multiparticle transfer studies.

33146 **Delayed-neutron energy spectra of $^{93-97}$Rb and $^{143-145}$Cs.** Greenwood, R.C.; Caffrey, A.J. (Idaho National Engineering Laboratory, EG & G Idaho, Inc., Idaho Falls, ID). *Nuclear Science and Engineering;* **91**: No. 3, 305-323(Nov 1985).

Measurements of the energy spectra of delayed neutrons for the isotope-separated, fission product precursors $^{93-97}$Rb and $^{143-145}$Cs, over the energy region from about 10 to about 1300 keV are reported. These data were obtained at the TRISTAN ISOL facility using gas-filled proton-recoil pro portional counters. The data for each of the rubidium and cesium isotopes show good qualitative agreement with the existing ^{3}He ionization chamber data at energies above about200 keV. In addition, they provide definitive spectral information down to about10 keV. Of particular note is the observation of line structure below about 200 keV with energy resolution much better than that obtained using ^{3}He ionization chambers.

6518 Nuclear Properties And Reactions, A=150-189, Theoretical

33147 (DOE/ER/40048—102-L4, pp 30-31) **Projectile breakup into coincident heavy fragments.** Awes, T.; Gil, S.; Harakeh, M.N.; Murphy, M.J.; Ray, A.; Seamster, A.G.; Vandenbosch, R. (Oak Ridge National Lab., TN). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

This experiment was inspired by the question: does the breakup of a massive projectile ever produce multiple heavy fragments? By heavy the authors mean larger than the protons, deuterons, and alphas characteristically emitted by excited nuclei. To investigate, they designed a system of four solid-state detector telescopes which was sensitive to coincident heavy ions with energies in excess of several MeV/n. This system was used to observe projectile-like particles emitted in the reaction of ^{35}Cl + Ta at 18 MeV/n. The measurement was made at the Holifield Facility at Oak Ridge National Lab., and succeeded in detecting projectile breakups into coincident heavy fragments. The results show a broad distribution of coincident events, representing all possible pairings of Z = 3 to Z = 8 projectile fragments. The authors obtained coincident energy spectra for all of these fragment pairs, and analyzed their features for information about the reaction mechanism. Most of the analysis employed Monte Carlo simulation of breakup scenarios as viewed by the detector system. They found that the simulation of a sequential breakup mechanism, in which the dissociation of the projectile remnant occurs far from the target, quantitatively reproduced all of the observed characteristics of the kinematic data.

33148 (DOE/ER/70035—7, pp 8-17) **Incomplete and complete fusion studies at intermediate energies. Part I.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

Last year we began a study of complete and incomplete fusion processes in the reaction of intermediate energy heavy ions with n-rich rare earth nuclei. During the past year, we completed a preliminary analysis of some of the data from the first experiments, prepared a manuscript summarizing our findings and have continued studying these phenomena using heavier intermediate energy projectiles (at GANIL) and different energy, lower mass projectiles (at CERN). In the first experiments to be completed, we measured the yields, angular distributions and differential range spectra for individual target fragments from the interaction of 8.5 MeV/A ^{16}O, 19 MeV/A ^{16}O, 35 MeV/A ^{12}C and 86 MeV/A ^{12}C with ^{154}Sm. From the measured data, fragment isobaric yields and velocity spectra were deduced. Data are compared to model predictions.

33149 (DOE/ER/70035—7, pp 20-21) **Ho target fragmentation induced by intermediate energy ^{12}C and ^{16}O.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

The study of the fragmentation of rare earth targets, such as Ho, by energetic heavy ions offers certain unique opportunities not found in similar studies with heavier targets. In a program begun previously, we have measured the target fragment yield distributions and kinematic properties for the interaction of 17-2100 MeV/A light heavy ions (C, O, Ne) with ^{165}Ho. Here we show the isobaric yield distributions deduced from measured nuclidic formation cross sections for the interaction of various intermediate energy ^{12}C and ^{16}O ions with ^{165}Ho.

33150 **(IAE—4012/2) Calculation of cross sections and polarizations of neutron scattering on deformed even-even nuclei by the coupled channel method.** Nemirovskij, P.Eh.; Kloss, Yu.Yu. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 21p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701978.

The coupled channel method application to the calculation of cross sections and polarizations of neutrons with 0.01-14 MeV energies on deformed even-even nuclei is considered. Results obtained for sup(152)Sm, sup(170)Er, sup(184)W, sup(238)U nuclei are presented on diagrams in the form of theoretically calculated curves. The dependence of cross sections and neutron polarizations on incident neutron energy and scattering angle is presented. Theoretical curves of total, elastic and inelastic cross sections are compared with the experimental data. It is necessary to note that a small shift (0.5 MeV) to the right along the E axis is observed for all theoretical curves. This shift is characteristic too for spherical nuclei sub(50)sup(115)Sn, sub(57)sup(139)La.

33151 **Excited states in neutron-deficient ^{195}Bi.** Loennroth, T.; Beausang, C.W.; Fossan, D.B.; Hildingsson, L.; Piel W.F. Jr.; Quader, M.A.; Vajda, S.; Chapuran, T.; Warburton, E.K. (Department of Physics, State University of New York, Stony Brook, New York 11794). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 5, 1641-1648(May 1986).

Excited states in ^{195}Bi were populated by the ^{182}W(^{19}F,6n) and ^{169}Tm(^{30}Si,4n) reactions. The subsequent γ-ray emission was studied using in-beam spectroscopic methods including excitation functions, γ-ray angular distributions, γ-γ-t coincidence, conversion

electron, and pulsed-beam-γ timing measurements. Three isomeric states were located in ^{195}Bi[J/sup π/,t/sub 1/2/,E]: [((13/2)$^{+}$), 32 +- 2 ns, 888 keV]; [((25/2)$^{+}$), 80 +- 10 ns, 2196 keV]; and [((29/2)$^{-}$), 750 +- 50 ns, 2311+Δ keV]. The structure of the observed states is interpreted within the shell-model framework. Systematic features of excited state energies and transition rates in the odd-A bismuth isotopes are discussed. A comparison of intruder states analogous to those in odd-A antimony nuclei of the Z = 50 transition region is made.

33152 **Identification of four new neutron-rich rare-earth isotopes.** Mach, H.; Piotrowski, A.; Gill, R.L.; Casten, R.F.; Warner, D.D. (Brookhaven National Laboratory, Upton, New York 11973; Clark University, Worcester, Massachusetts 01610; and University of Maryland, College Park, Maryland, 20742). *Physical Review Letters;* **56**: No. 15, 1547-1550(14 Apr 1986). Contract AC02-76CH00016;AC02-79ER10493;AS05-79ER10494.

Four new neutron-rich, fission-product nuclei have been identified at the on-line mass separator TRISTAN at Brookhaven National Laboratory. Their half-lives have been measured to be, for ^{156}Pm, T/sub 1/2/ = 28.2 +- 1.1 sec; for ^{159}Sm, T/sub 1/2/ = 15 +- 2 sec; for ^{160}Sm, T/sub 1/2/ = 8.7 +- 1.4 sec; and for ^{161}Eu, T/sub 1/2/ = 27 +- 3 sec. These nuclei are of particular importance in nucleosynthesis calculations, since they lie in the region of the rare-earth maximum in r-process abundances. A comparison of these and other new half-lives with recent calculations discloses a characteristic pattern of discrepancies.

6519 Nuclear Properties And Reactions, A=190-219, Theoretical

33153 (DOE/ER/40048—102-L4, pp 16-17) **Forward-to-backward asymmetries in the (γ,n) reactions around the E2 isovector giant resonance.** Debevec, P.T.; Dowell, D.H.; Halpern, I.; Morford, L.J.; Murakami, T.; Storm, D.W.; Tieger, D.R.; Wender, S.A. (Univ. of Illinois, Urbana). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

Experiments were performed by using the 39.4 MeV continuous electron beam from the University of Illinois microtron using a superconducting linac (MUSL-2) and the tagged photon facility. The front-to-back asymmetries [Y(55°)-Y(125°)]/[Y(55°)+Y(125°)] for the (γ,n) reaction were measured in three targets as a function of photon energy between 20 and 30 MeV. The neutrons were measured by an NE-213 liquid scintillator which was 30 cm in diameter and 5.1 cm thick. The asymmetry curves for ^{206}Pb and /sup nat/Pb for residual excitations between 0 and 4 MeV in the photon energy range of 20 to 26 MeV were identical within the experimental uncertainties. The asymmetries were about 0.2 for the lower photon energies and made a transition near E/sub γ/ ~ 23 MeV to ~0.6 for the higher energies. For /sup nat/Cd the pattern was similar but the transition region was about 4 MeV higher, consistent with the expected A/sup -1/3/ dependence of the locations of giant resonances. The detailed analysis of the energy dependence of the asymmetry, using the direct-semidirect model, is in progress.

33154 (DOE/ER/70035—7, pp 3-7) **Target fragment angular distributions in the interaction of 86 MeV/A ^{13}C with ^{197}Au.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

In last year's Annual Report, we reported the results of the measurement of the target fragment angular distributions for 69 different fragments (44 ≦ A ≦ 196) from the interaction of 86 MeV/A ^{13}C with ^{197}Au. During the past year, we have finished our analysis of these data and have prepared an article describing the data for publication in Nuclear Physics. For some representative fragments the laboratory system angular distributions are forward-peaked with some distributions also showing backward peaking. We have compared the shapes of these distributions with the predictions of the nuclear firestreak model and find the measured angular distributions to differ markedly from the firestreak model predictions for most cases.

33155 (DOE/ER/70035—7, pp 19-20) **Target fragment kinematics for the reaction of 49 MeV/A ^{12}C with ^{197}Au.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

The reaction mechanism(s) responsible for the formation of light fragments (A < 60) from a heavy nucleus such as ^{197}Au as the result of a heavy ion- heavy target interaction have not been clearly identified. To help us in understanding the formation of these fragments, we undertook a measurement of the angular distribution and differential ranges of these fragments in the interaction of 49 MeV/A ^{12}C with ^{197}Au. Along with these measurements, we also measured the angular distributions and differential range spectra of the heavy target fragments (A 140) from this reaction. Analysis of these data is in progress.

33156 (DOE/ER/70035—7, pp 23-25) **Target fragment kinematics in the interaction of 44 MeV/A ^{40}Ar with ^{197}Au.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

During the past year, we measured the angular distribution and differential range distribution for target fragments from the interaction of 44 MeV/A ^{40}Ar with ^{197}Au using the facilities of GANIL. Data acquisition continues as of this writing. We show the laboratory system angular distribution of a few selected target fragments from this reaction along with similar data from the interaction of 86 MeV/A ^{13}C with ^{197}Au.

33157 (DOE/ER/70035—7, pp 34-37) **^{197}Au target fragmentation induced by 1.8 GeV/A ^{40}Ar.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

As first reported in last years Annual Report, we have attempted to extend the experimental range of validity of the concepts of limiting fragmentation and factorization for heavy target systems by measuring the fragment production cross sections and kinematic properties for the interaction of 72 GeV ^{40}Ar with ^{197}Au. A range-weighted measure of the target fragment angular distribution is the F/B ratio, the ratio of fragments recoiling forward from a target (F) to those fragments recoiling backwards (B). We show the dependence of F/B for selected fragments from ^{197}Au target fragmentation upon the total projectile kinetic energy and isobaric yield distributions.

33158 **Intermediate and weak coupling in ^{219}Ra.** Cottle, P.D.; Gai, M.; Ennis, J.F.; Bromley, D.A.; Beausang, C.W.; Hildingsson, L.; Piel, W.F. Jr.; Fossan, D.B.; Olness, J.W. (A.W. Wright Nuclear Structure Laboratory, Yale University, New Haven, Connecticut 06511). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 5, 1855-1858(May 1986). Contract AC02-76ER03074;AC02-76CH00016.

The level scheme of ^{219}Ra established via a study of the ^{208}Pb(^{14}C,3n)^{219}Ra reaction is presented. The structure of the rotational band based on the ground state is interpreted as reflecting a g(sub 9/2) valence neutron weakly coupled to a spherical ^{218}Ra core. A non-yrast side band is observed, having tentative (11/2)$^{-}$, (15/2)$^{-}$, . . . level assignments. An (11/2)$^{-}$ state could result from the anomalous J = j-2 intermediate strength coupling of a j(sub 15/2) neutron to the ^{218}Ra core. The relevance of a weak coupling model to the understanding of high spin (J>j) parity doublets and the surprisingly different experimentally observed level schemes of 2 $_{88}$^{19}Ra and 2 $_{89}$^{19}Ac are discussed.

33159 **Measurement of $\pi i/\pi^{-}$ cross section ratio for the giant quadrupole resonance in ^{208}Pb.** Seestrom-Morris, S.J.; Morris, C.L.; Moss, J.M.; Carey, T.A.; Drake, D.; Dousse, J.H.; Bland, L.C.; Adams, G.S. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545; University of Minnesota, Minneapolis, Minnesota 55455). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 5, 1847-1850(May 1986).

Cross sections have been measured for π^+ and π^- scattering to the giant resonance region of ^{208}Pb with 162-MeV pions. The value of $R = \sigma(\pi^-)/\sigma(\pi^+)$ measured for the giant quadrupole resonance is 2.72. A distorted wave impulse approximation analysis of these data using collective model form factors gives the ratio of neutron to proton matrix elements to be 3.8. This is much larger than expected from the hydrodynamical model which predicts a value of N/Z of 1.54.

33160 **Nuclear data sheets for A = 208.** Martin, M.J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Nuclear Data Sheets;* 47: No. 4, 797-964(Apr 1986). Contract AC05-84OR21400.

Detailed level schemes, decay schemes, and the experimental data on which they are based are presented for all nuclei with mass number A = 208. The experimental data are evaluated; inconsistencies and discrepancies are noted; and adopted values for level and γ-ray energies, γ intensities, as well as for other nuclear properties are given.

6520 Nuclear Properties And Reactions, A=220 And Above, Theoretical

REFER ALSO TO CITATION(S) 33133, 33150

33161 (DOE/ER/40048—102-L4, pp 21-22) **Study of spin-spin correlations in deep inelastic collisions.** Gobbi, A.; Hildenbrand, K.; Kuzminski, J.; Lazzarini, A.; Mueller, W.; Olmi, A.; Steltzer, H.; Toke, J. (GSI, Darmstadt, West Germany). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The authors have performed a measurement from which they can infer the spin-spin correlations in a deeply inelastic collision. They have exploited the fact that the angular distribution of fragments produced in the fission of a binary partner in deeply inelastic collision is highly anisotropic, and that the anisotropy can be used as a tool to probe the alignment and magnitude of the spin of the fissioning system. Here the authors use a reaction in which both beam and projectile are fissile nuclei. In this manner the bulk of the deep inelastic yield results in final states in which both deeply inelastically scattered fragments have fissioned. The angular correlation of this four-body final state then contain information which may be related to the relative orientation of the spins of the two fragments before they fissioned. The authors have used the ^{208}Pb + ^{238}U reaction at E/sub cm/ = 945 MeV at the GSI Unilac to make their measurements. The four fragments were detected in an array of six avalanche detectors. One array consisted of two detectors on one side of the beam axis. In this manner the two correlated fragments arising from the fission of one nucleus could be observed, thus defining the mass transfer, energy loss and reaction plane for the deep inelastic collision. In addition, they sampled the mass distribution independently using three surface barrier detectors as time-of-flight telescopes.

33162 (DOE/ER/40048—102-L4, pp 32-34) **How is the excitation energy divided in partially damped collisions?.** Lazzarini, A.; Leach, D.D.; Lock, D.K.; Ray, A.; Seamster, A.G.; Vandenbosch, R. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

One of the principal remaining questions concerning quasi- and deeply-inelastic collisions is the division of the excitation energy between the two fragments. The authors have developed a new method for determining the division of excitation energy and applied it to the very mass asymmetric entrance channel system ^{56}Fe + ^{238}U. They determine the total excitation energy from the kinetic energy of the projectile-like fragment and the excitation energy appearing in the heavy fragment from the fission mass asymmetry of the coincident sequential fission fragments from the target-like partner. The relative yields of symmetric and asymmetric fission fragments is a very sensitive function of energy for excitation energies below about 60 MeV.

33163 (DOE/ER/70035—7, pp 30-34) **Uranium target fragmentation by intermediate and high energy ^{12}C and ^{20}Ne.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

In previous Annual Reports, the measurement and analysis of the target fragment formation cross sections for nuclides with $24 \leqq A \leqq 237$ from the interaction of 1.0, 3.0, 4.8, 12 GeV ^{12}C and 8.0, 20.0 GeV ^{20}Ne with ^{238}U has been reported. During the past year, final analysis of these measurements was completed and an article prepared for publication. We show the excitation functions for the formation of mostly independent yield nuclides that are representative of various classes of U target fragments and isobaric yield distributions.

33164 (DOE/ER/70035—7, pp 43-45) **Predicted halflives of transuranium nuclei.** Sep 1984. NTIS, PC A04/MF A01. File Number DE85011464.

In Nuclear chemistry progress report, September 1, 1983-August 31, 1984.

We are currently writing a monograph tentatively entitled The Elements Beyond Uranium for Wiley-Interscience. Chapters on the discovery of the transuranium elements, their chemical and physical properties, their nuclear properties, experimental techniques of studying them, their presence in nature, superheavy elements nuclear synthetic techniques, and practical applications have been written or are planned. The expected length of the book is ~ 250 pages. In connection with this effort, we have reviewed existing data on the halflives for electron capture, α and β-decay and spontaneous fission for the transuranium nuclei and we have used a set of semiempirical systematics to predict the halflives of unknown transuranium nuclei for Z = 93-110, and neutron numbers between the neutron and proton drip lines. A portion of these predictions (for the lighter actinides) is shown.

33165 **(FEI—1564) Investigation of emission neutron spectra from thorium 232 and uranium 235 for the 6 MeV neutrons.** Lovchikova, G.N.; Polyakov, A.V.; Sal'nikov, O.A.; Simakov, S.P.; Sukhikh, S.Eh.; Trufanov, A.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1984. 14p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701992.

Emission spectra of neutrons produced during bombardment of sup(232)Th and sup(235)U nuclei by 6.02 +- 0.12 MeV neutrons at 30 deg, 45 deg, 60 deg, 90 deg, 120 deg and 150 deg to the beam of incident neutrons were measured. Double-differential cross sections of inelastic neutron scattering were obtained. The values of integral cross sections of inelastic scattering are equal to 3.12 +- 0.50b for sup(232)Th and 1.98 +- 0.40b for sup(235)U. The comparison of present results with the data obtained by other authors and estimated values of inelastic scattering cross section is presented. The estimated values lie somewhat below the results of the given study but within the limits of measurement errors. The obtained cross section for sup(235)U at 6 MeV energy supports the tendency to the decrease of inelastic scattering cross section with growth of incident neutron energy.

33166 **(IAE—3862/2) Study on the aligned uranium-235 nuclear decay in the neutron energy range of 1.7 eV - 2.15 keV.** Danelyan, L.S.; Zakharov, Yu.V.; Zykov, V.M.; Mostovoj, V.I.; Stolyarov, V.A.; Biryukov, S.A.; Zysina, N.Yu.; Osochnikov, A.A.; Svettsov, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1983. 17p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701993.

Using a time-of-flight neutron spectrometer comparative measurements of intensity of fission reaction on the aligned and non-oriented uranium-235 nuclei have been performed in order to identify the resonances caused by p-neutron capture as well as to determine the p-neutron contribution to the fission cross section in the region of unresolved resonances. In some isolated resonances differences in cross sections on aligned and non-oriented nuclei of about 10% have been observed which can permit to assign them to

p-resonances. In the region of unresolved resonances in the 0.15-2.15 keV neutron energy range to the accuracy +-1% no changes in the fission cross section during the nuclear alignment have been oberved.

33167 (IPEN-Pub—83) Study of ^{237}Np photonuclear reactions near threshold, induced by gamma rays from thermal neutron capture. Geraldo, L.P.; Vinhas, L.A.; Cesar, M.F. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701994.

The photodisintegration of ^{237}Np has been studied using monochromatic photons produced by thermal neutron capture in several materials. The partial cross sections σ gamma, sub(f) and σ gamma, sub(n) were measured in the energy interval from 5.43 MeV to 10.83 MeV. Analysing the photofission data according to the liquid drop model, the height (E sub(f)) and the curvature ((h/2π)ω) of the simple fission barrier were determined: E sub(f) = (5.9 $^{+-}$ 0.2) MeV and (h/2π)ω = (0.8 $^{+-}$ 0.4) MeV. For the competition between photoneutron emission and fission (GAMMA sub(n) / GAMMA sub(f)) a constant value was found (1.28 $^{+-}$ 0.15) in the energy range 6.73 - 10.83 MeV. From this result the following nuclear temperatures for ^{237}Np were extracted on bases of some models of levels density: T = 0.84 $^{+-}$ 0.06 MeV (Fujimoto-Yamaguchi model) and T = 0.60 $^{+-}$ 0.04 MeV (Constant Nuclear temperature model).

33168 (JINR—R-2-85-124) Neutron production by action of high-energy nucleus beam. Barashenkov, V.S.; Levchuk, L.G.; Musul'manbekov, Zh.Zh.; Sosnin, A.N.; Shmakov, S.Yu. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1985. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701983.

Submitted to the journal Sov. J. At. Energy.

The propagation of α and ^{12}C ion beams with the energy 1 GeV/nucleon in the fissionable target has been simulated using Monte-Carlo technique. Results of calculations are compared with the corresponding data for proton and deuteron beams.

33169 (JINR—R-7-85-267) Fragment angular distribution and fission reaction duration. Karamyan, S.A.; Bugrov, V.N.; Spiridonov, N.I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1985. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701995.

Submitted to the journal Sov. J. Nucl. Phys. .

Detailed measurements of fission fragment angular distributions are carried out under irradiation of sup(238)U target with ^{4}He, ^{12}C and ^{22}Ne ions. Structure peculiarities of the distributions have not been found within the limits of 2-3% experiment errors. Regular dependences of the cross section on the angle are characterized by the anisotropy values which agree with the published data. The shape of angular distribution permits to assume a noticeable contribution of fission after reactions with incomplete momentum transfer. Possible peculiarities of angular distribution in the case of preequilibrium system fission are discussed. The estimation of time duration has been performed for several reactions on the base of angular distributions. Systematics of the compound nuclei lifetimes in the 10^{-20}-10^{-15} s interval is presented.

33170 Semimicroscopic calculations of elastic, inelastic, and total neutron scattering by ^{239}Pu in the energy range 10 keV < or =E/sub n/< or =10 MeV. Lagrange, C.; Madland, D.G.; Girod, M. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 5, 1616-1623(May 1986).

We investigate the capabilities of a semimicroscopic optical model potential involving fewer adjustable parameters than phenomenological models and test the sensitivity of this potential to various rotational band assumptions. Our analysis of the model capabilities is performed using experimental elastic, inelastic, and total cross sections as well as experimental neutron strength functions. We compare our calculations to these experiments and to the predictions of a phenomenological model. Our sensitivity study is performed for the first three rotational bands of ^{239}Pu. The two main ingredients of our calculations are the microscopic optical-model potential of Jeukenne, Lejeune, and Mahaux and nuclear densities from Hartree-Fock-Bogoliubov calculations using the density-dependent force D_1.

33171 Neutron capture cross section of ^{243}Am. Weston, L.W.; Todd, J.H. (Oak Ridge National Laboratory, Oak Ridge, TN). *Nuclear Science and Engineering;* **91**: No. 4, 444-450(Dec 1985).

The neutron capture cross section of ^{243}Am was measured from 258 eV to 92 keV. The relative capture cross sections were normalized to 74.8 b at 0.0253 eV from ENDF/B-V. Agreement with the one previous measurement in the kilo-electron-volt neutron energy range is reasonably good (about 8%). These results are needed for calculating the buildup of higher actinides in operating reactors.

33172 Neutron inelastic scattering cross sections for states above 700 keV in ^{232}Th. Ciarcia, C.A.; Couchell, G.P.; Egan, J.J.; Kegel, G.H.R.; Li, S.Q.; Mittler, A.; Pullen, D.J.; Schier, W.A.; Shao, J.Q. (University of Lowell, Department of Physics and Applied Physics, Lowell, MA). *Nuclear Science and Engineering;* **91**: No. 4, 428-443(Dec 1985).

Fast neutron inelastic scattering cross sections for levels between 700- and 1400-keV excitation energy in ^{232}Th have been measured using the (n,n') time-of-flight (TOF) technique. Measurements of 125-deg differential cross sections were made using neutrons with a typical energy spread of 8 to 10 keV, generated by the ^{7}Li(p,n)^{7}Be reaction. The incident neutron energies covere three regions: (a) 950 to 1550 keV in 50-keV intervals with the TOF spectrometer optimized to detect 200 to 600-keV scattered neutrons, (b) 1200 to 2000 keV in 100-keV intervals with the spectrometer optimized to detect 400- to 800-keV scattered neutrons, and (c) 1700 to 2100 keV in 100-keV steps with the spectrometer optimized for 800- to 1300-keV scattered neutrons. Throughout the experiment, an overall energy resolution of <15 keV was maintained. Level cross sections were deduced from the 125-deg differential scattering cross sections and are compared with (n,n'γ) measurements and the ENDF/B-V evaluation. Angular distributions for states in the 700- to 900-keV region have been measured at 1.2, 1.5, and 2.0 MeV.

6530 Nuclear Theory

33173 (BNL—38026) Symmetries in heavy nuclei and the proton-neutron interaction. Casten, R.F. (Brookhaven National Lab., Upton, NY (USA)). 1986. Contract AC02-76CH00016. 20p. (CONF-8603115—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010548.

From Symmetries in science II; Carbondale, IL, USA (24 Mar 1986).

The Interacting Boson Approximation (IBA) nuclear structure model can be expressed in terms of the U(6) group, and thereby leads to three dynamical symmetries (or group chains) corresponding to different nuclear coupling schemes and geometrical shapes. The status of the empirical evidence for these three symmetries is reviewed, along with brief comments on the possible existence of supersymmetries in nuclei. The relationships between these symmetries, the nuclear phase transitional regions linking them, and the residual proton-neutron interaction are discussed in terms of a particularly simple scheme for parameterizing the effects of that interaction. 34 refs., 15 figs.

33174 (CEA-CONF—7963) Antiproton-nucleus interaction: review of the experimental situation. Garreta, D. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France)). May 1985. 24p. (CONF-8505265—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751783.

From Conference on antinucleon and nucleon-nucleus interaction; Telluride, CO, USA (18 May 1985).

This paper will review the experimental situation of a few well-defined channels of the anti-p-nucleus interaction where the antiproton does not annihilate. It will not mention any experiment which studies annihilation of antiporotons in nuclei. The anti-p-nu-

cleus reactions that will be reviewed are the following: 1. A(anti-p,anti-p)A elastic scattering which deals with the anti-p-nucleus system in a positive energy state. 2. Anti-p-nucleus atoms where the anti-p-nucleus system is almost at zero energy and interacts mostly through the Coulomb interaction, the strong interaction being only a perturbation. 3. A(anti-p,p)X proton knock-out reaction used to produce possible bound states or resonances of the anti-p-nucleus system via strong interaction. The main reasons for studying these three channels are to provide information about the anti-p-nucleus optical potential and also, through microscopic calculations which use the elementary anti-NN amplitudes and the nuclear matter densities as inputs, to get information about these quantities. 4. A(anti-p,anti-p')A* inelastic scattering - inelastic in the sense that the nucleus is left in an excited state but the antiproton does not annihilate, that is it deals only with the elastic part of the elementary anti-NN amplitude. Inelastic scattering from collective states also sets constraints on the anti-p-nucleus potential when analysed in terms of coupled-channel calculations. When unnatural parity states are concerned, it provides a sensitive test of the spin and isospin components of these amplitudes. In addition, this paper will focus essentially on the recent experiments performed at LEAR.

33175 **(CEA-CONF—8040) What can be learned from coincidence experiments from nuclei.** Mougey, J.Y. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Jun 1985. 46p. (CONF-8506152—5; DPh-N-S—2294). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751782.

From CEBAF summer workshop; Newport News, VA, USA (3 Jun 1985).

This paper summarizes the present status and open problems in electron induced coincidence experiments below pion threshold and indicates future possible developments using high energy continuous electron beams. The recent work on quasi-elastic (e,e'p) reactions is briefly reviewed with some emphasis on electrodisintegration of few-body systems. The use of (e,e'p), (e,e'd), (e,e'2N) reactions to study two-nucleon correlations is discussed. Quasi-elastic (e,e'N) experiments to investigate possible modifications of nucleon electromagnetic properties in nuclear medium are described.

33176 **(CEA-CONF—8145) Dynamics of the input parameters.** Ngo, C. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF)). Sep 1985. 9p. (In French). (CONF-8509237—2; DPh-N-S—2302). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751779.

From National congress of the French Physical Society; Nice, France (9 Sep 1985).

Few typical examples of reaction mechanisms observed in heavy ion collisions at low, medium and high bombarding energies are presented. The present paper is primarily addressed to non specialists in the field. 18 refs.

33177 **(DOE/ER/02853—28) Electronuclear reactions and meson exchange currents.** Dubach, J. (Massachusetts Univ., Amherst (USA)). 1985. Contract AC02-76ER02853. 47p. (CONF-8506156—2). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010633.

From Los Alamos workshop on relativistic dynamics and quarks in nuclear physics; Los Alamos, NM, USA (10 Jun 1985).

The electromagnetic structure of the nucleus is described in terms of nucleon and meson degrees of freedom. The basic description of electron scattering in the formalism of Quantum Electrodynamics (QED) is reviewed, first in general terms and then with specific applications to nuclear physics. Construction of the nucleon current operators is briefly discussed. The calculational techniques for including the electromagnetic currents due to the exchange of mesons are then presented. The historical evidence for these "meson exchange currents" is reviewed and the present status of the confrontation between theory and experiment is summarized. Finally, speculation about the future directions in this field is offered. 44 refs., 23 figs.

33178 (DOE/ER/40048—102-L4, pp 29-30) **Calculation of critical energies as a function of nuclear size.** Cramer, J.G.; Loveman, R.A. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

There is a singularity in the classical deflection function of many potentials. In particular, the potentials used to characterize scattering of nuclei fall into this class. There is however a scattering energy above which this singularity in the defection function disappears. This energy is the critical energy. This energy divides elastic scattering into two regimes. Above the critical energy one might expect to see nuclear rainbows and negative angle scattering. Below it one would expect to see phenomena associated with nuclear orbiting. The authors are beginning a study of critical energies of different systems. For this study they will be using folding model potentials calculated by the same method used by Satchler and Love.

33179 (DOE/ER/40048—102-L4, pp 88-89) **Continuous-l optical model program.** Cramer, J.G. (Univ. of Washington, Seattle). Apr 1984. NTIS, PC A06/MF A01. File Number DE85007866.

In Nuclear Physics Laboratory annual report.

The author has developed the computer program DEFL which evaluates the optical model S-matrix and the quantal deflection function in arbitrarily small steps of l. An Argand diagram of the continuous S-matrix calculated for the $^{16}O + ^{16}O$ system at 40 MeV, using the well known Gobbi potential developed at Yale is shown. The kinks in the S-matrix reflect shape resonances generated by the potential.

33180 **(FEI—1566) Projection method for calculation of multi-particle resonances.** Emel'yanov, V.G.; Klimov, V.I.; Pomerantsev, V.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1984. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701975.

The previously suggested approach to the theory of resonance processes using the method of orthogonal projection is considered. On the base of a developed numerical scheme resonances in the α-n system are studied. The interation is chosen in the form of Woods-Saxon potential. As three-body model the three-boson system with Yamaguchi s-wave separable interaction with total moment L=1 and 2 is investigated.

33181 **(FEI—1567) On a description of resonances in an oscillator representation of the scattering theory.** Asherova, R.M.; Nechaev, Yu.I.; Smirnov, Yu.F. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.; Moskovskij Gosudarstvennyj Univ. (USSR). Nauchno-Issledovatel'skij Inst. Yadernoj Fiziki). 1984. 22p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701976.

Two methods of a search for resonance characteristics in scattering and reactions in the framework of an oscillator n representation are considered. The first method consists in finding complex poles of the S matrix. Taking as example a simple separable potential it is shown that scattering theory equations in n representation really permit to find the position and widths of resonances related to such poles. It is shown as well that the scattering theory in n representation has much in common with the usual scattering theory in coordinate representation. In fact, each notion of the usual scattering theory has its discrete analog in n space. In particular, in the paper discrete Panalog of the Jaffe-Low matrix is introduced and in approximation isolated resonance Breit-Wigner formulas for amplitude of scattering and reaction are obtained. In the above approximation partial widths and energies of resonances are most simply related to poles and residues of the p matrix obtained as a result of standard diagonalized calculations.

33182 **(FEI—1568) On an effective method for solution of a strong channel coupling problem.** Tertychnyj, G.Ya. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk. Fiziko-Ehnergeticheskij Inst.). 1984. 18p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701977.

A new calculational scheme of the strong channel coupling method (SCCM) was developed on the basis of random phase approximation with account for one-particle continuum. Preserving

all SCCM advantages it surmounts many restrictions and difficulties of a traditional method of task solution - direct integration of a set of integro-differential equations. Use of transient density and coordinate representation for the Green function enables one to operate in calculations with total 1p-1h basis and simply to take account of the Pauli principle. To solve integral equations a quick and sufficiently precise method using the Fourier-Bessel expansion for transient density is applied.

33183 **(GSI—86-4-Prepr.) Nuclear self energy - semiclassically.** Hasse, R.W. (Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.); Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.)). Feb 1986. 15p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751761.

From 24. international winter meeting on nuclear physics; Bormio, Italy (1986).

By using semiclassical methods the polarization and correlation contributions to the real and the imaginary part of the optical potential are calculated. Together with an underlying mean field of Perey-Buck form we calculate and present results of the depths of the single-particle potentials, the effective mass as function of energy, radius and temperature, the single-particle level density and the occupation numbers. By folding the occupation numbers into a Hartree-Fock density the charge densities at the centers become smooth and better in agreement with experiment than those without correlation effects. (orig.).

33184 (INIS-SU—324, pp 3-7) **On nuclear effects in deep inelastic scattering of electrons and muons.** Savin, I.A.; Smirnov, G.I. 1984. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86780460.

In JINR rapid communications. Collection.

An assumption on the dependence of parameter R=σsub(L)/σsub(T) (where σ(w sub(L)) and σsub(T) are absorption cross sections of longitudinal and transversal photons respectively) on the atomic weight of nucleus A in the form R=aAsup(1/3) is suggested to be used for the analysis of data on deep inelastic electron scattering on nuclei. Attention is paid to :he importance of correct account of value R in such experiments as compared with those on deep inelastic muon scattering, where R approximately 0. It is shown that with the suggested dependence R(A) the results obtained till now in experiments with electrons and muons will be compatible.

33185 (INIS-SU—325, pp 35-38) **On spin-orbital splitting of neutron 3p-strength functions in Sn isotopes.** Voronov, V.V.; Stoyanov, Ch. (Joint Inst. for Nuclear Research, Dubna, USSR. Lab. of Theoretical Physics). 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE86780459.

In JINR rapid communications. Collection.

The neutron strength functions are defined by the fragmentation of one-quasiparticle component of the wave functions over many nuclear states due to a residual interaction. It is shown that the p-wave strength functions with the angular momentum of the compound nuclei J=1/2 are much higher than ones with J=3/2. These results are in agreement with the experimental data on spin-orbital splitting of 3p-strength neutron functions obtained at the Laboratory of Neutron Physics, JINR.

33186 (INIS-SU—325, pp 43-52) **Search for anomalous interaction of relativistic fragments of ^{24}Mg nucleus by means of a Cherenkov spectrometer.** Veres, I.; Golovin, V.M.; Golutvin, I.A. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE86780459.

In JINR rapid communications. Collection.

The results of the electronic experiment on the investigation of the projectile fragments interaction are presented. The experiment is made at 4.5 GeV/c ^{24}Mg beam of the JINR synchrophasotron. The main part of the apparatus is the live target assembled of 40 Cherenkov counters with 5 mm thick lucite radiator. Charge changing reactions for the primary beam and secondary fragments with 6 <= z <= 11 have been registered. The interaction mean free path of the projectile fragments and probabilities of its production based on the analysis of 10^5 interactions are presented. The absorption function is well represented by one (normal) exponential. The upper limit of the anomalous component contribution α is obtained assuming that it has mean free path of 1 cm. The result is: α < 1.4%, on an average over 6 <= Z <= 11 with 95% confidence level.

33187 **(INP—1173/PH) Linking total cross-sections for hard and soft processes through analyticity in Q^2 and sum rules.** Kwiecinski, J. (Institute of Nuclear Physics, Krakow (Poland)). 1982. 16p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701979.

Using analyticity of the virtual Compton amplitude in Q^2 sum rules derived are rules relating meson-nucleon total cross-sections with certain integrals over large Q^2 and x=0 part of nucleon structure functions. Preliminary quantitative analysis of the sum rules for both singlet and non-singlet amplitudes is presented. For the singlet amplitude the sum rules relate, in particular, the rise of sea-quarks distributions implied by perturbative QCD and increase of total meson-proton cross-sections with energy. Quantitatively, however, nonunitary leading log Q^2 results for the former give too rapid increase of the latter. (author).

33188 **(INP—1193/PL) Compilation of investigated fusion reactions with heavy ions. Supplement. Part 2. Z_1h11-92.** Rogalska, Z. (Institute of Nuclear Physics, Krakow (Poland)). 1982. 42p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86701986.

The compilation covers data published and included in Physics Abstracts from April 1, 1980 to December 31, 1980. The information on type of reaction, measurement technique, projectile energy as well as on main investigation results is given.

33189 **(ITEP—192(1983)) Neutron-to-proton ratios in pA and πip A interactions.** Bayukov, Yu.D.; Degtyarenko, P.V.; Druzhinin, B.L. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Teoreticheskoj i Ehksperimental'noj Fiziki). 1983. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701988.

Measurements of neutron and proton yields at 120 deg have been carried out in 7.5 GeV/c pA and in 1.4 GeV/c and 5.0 GeV/c π^{+-}A interactions. The ratios of secondary neutrons to protons are considered in detail. The ratios depend on kinetic energy of secondary nucleons and this dependence is more pronounced for heavy nuclei. Dependence of these ratios on the incident particle charge and the asymmetry resulting from a different number of protons and neutrons in the nucleus are discussed.

33190 **(ITP—85-8-E) Limiting model-independent correlations between three-particle parameters.** Simenog, I.V.; Shapoval, D.V. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701981.

The limiting model-independent correlations between low-energy parameters and spectrum of three spinless particles are found. Due to the smallness of the range of forces the correlation dependences between scattering parameters and energy levels of three-particle systems revealed in calculations for different model interaction potentials are explained both qualitatively and quantitatively on the basis of the model-independent description. These regularities can be applied to the important case of double scattering.

33191 **(JINR—1-84-185) On a quark distribution in nuclei.** Baldin, A.M.; Panebrattsev, Yu.A.; Stavinskij, V.S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1984. 7p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701974.

Some regularities which follow from the experimental data on cumulative meson production are considered. They provide evidence in favor of the existance in nuclei of multiquark states whose structure strongly differs from nucleons. The condition is proposed, defining the region in which hadrons lose the role of quasiparticles of nuclear matter. The boundaries of applicability of the proton-neutron nuclear model are established.

33192 (JINR—1-84-240) Associative production of fast fragments emitted backward in nucleus-nucleus collisions. Anikina, M.Kh.; Vardenga, G.L.; Gazdzitskij, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1984. 10p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701989.

Submitted to the journal Sov. J. Nucl. Phys. .

The associative production of fast fragments emitted into the back hemisphere during particle- or nucleus-nucleus interaction is investigated. The experimental material is obtained during irradiation of streamer chamber SKM-200 by ^{4}He, ^{12}C and ^{16}O nuclei with initial momentum of 4.5 GeV/c per nucleon. The collisions with pure targets of C, Ne, Cu and Pb are investigated. Momenta and angular characterisitics of all positive particles having a momentum more than 300 MeV/c, exit angle - 120 deg and slope angle to horizontal plane less than 30 deg are measured. The results are given of the investigation of correlation between fast fragments emitted backwards and accompanying π^- mesons as well as protons knocked out of the target in nucleus- nucleus collisions. The data obtained are analyzed in the framework of the cascade model.

33193 (KFK—4007) Break up of light ions in the nuclear and Coulomb field of nuclei. Srivastava, D.K. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Kernphysik). Dec 1985. 67p. (CONF-8509159—5). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751754.

From 17. international summer school on nuclear physics; Mikolajki, Poland (2 Sep 1985).

The break up of light ion projectiles in the nuclear and Coulomb field of nuclei is considered. Current theoretical concepts for describing break up processes and their theoretical features are discussed. An alternative method, based on a prior-interaction DWBA, is introduced for the calculation of the direct elastic break up cross sections. This method reveals the role of the internal momentum distribution of the break up fragments and includes corresponding 'finite range' effects. The Coulomb break up of ^{6}Li is studied on the basis of a quasi-sequential break up approach (following Rybicki and Austern) and results are obtained for very low relative energies of the emerging α-particles and deuteron fragments. The astrophysical interest in these cross sections is noted. A view on further extensions of the break up theory is given. (orig.).

33194 (LA—10689-PR) Applied nuclear science research and development progress report, June 1, 1985-November 30, 1985. Arthur, E.D.; Mutschlecner, A.D. (comps.). (Los Alamos National Lab., NM (USA)). Apr 1986. Contract W-7405-ENG-36. 120p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86009799.

This six month progress report reviews activities in nuclear reaction research. Specific content includes theory and evaluation of nuclear cross sections for neutron, proton, and deuteron reactions for a number of isotopes; the processing and testing of nuclear cross section data; studies of neutron activation, fission products and actinides; and short notes on applications. Data are included in graphic and tabular form and include experimental, evaluated, and theoretical calculations and spectra. 136 refs., 81 figs., 17 tabs. (DWL)

33195 (LA-UR—86-1175) Effect of dissipation on dynamical fusion thresholds. Sierk, A.J. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 20p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010168.

The existence of dynamical thresholds to fusion in heavy nuclei ($A \geqq 200$) due to the nature of the potential-energy surface is shown. These thresholds exist even in the absence of dissipative forces, due to the coupling between the various collective deformation degrees of freedom. Using a macroscopic model of nuclear shape dynamics, It is shown how three different suggested dissipation mechanisms increase by varying amounts the excitation energy over the one-dimensional barrier required to cause compound-nucleus formation. The recently introduced surface-plus-window dissipation may give a reasonable representation of experimental data on fusion thresholds, in addition to properly describing fission-fragment kinetic energies and isoscalar giant multipole widths. Scaling of threshold results to asymmetric systems is discussed. 48 refs., 10 figs.

33196 (LBL—21272) Tilting mode in nuclear reactions. Dossing, T.; Randrup, J. (Lawrence Berkeley Lab., CA (USA)). Feb 1986. Contract AC03-76SF00098. 7p. (CONF-860270—7). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009357.

From 4. winter workshop on nuclear dynamics; Copper Mountain, CO, USA (24 Feb 1986).

The relation between tilting relaxation and the reaction plane dynamics is discussed, providing an intuitive understanding of the expression for the cross section close to the beam direction, which has recently been derived. Second, the tilting relaxation time and the related wriggling relaxation time are discussed, based upon nucleon exchange transport (window friction). Finally, recent experimental information on the tilting mode relaxation is discussed, and the dynamics of the tilting mode is discussed qualitatively for the three different types of nuclear reactions considered, compound nucleus fission, quasifission, and damped nuclear reactions. 9 refs., 3 figs.

33197 (UCRL—92492-Rev.1) Importance of level structure in nuclear reaction cross-section calculations. Revision 1. Gardner, M.A.; Gardner, D.G. (Lawrence Livermore National Lab., CA (USA)). 7 Nov 1985. Contract W-7405-ENG-48. 16p. (CONF-850942—54-Rev.1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86009603.

From 190. American Chemical Society national meeting; Chicago, IL, USA (8 Sep 1985).

It is shown that level-density expressions cannot adequately represent or substitute for level structure information when making calculations of the Hauser-Feshbach type for cross sections or isomer-ratios for nuclei in the first few MeV above their ground state. It is stated that such discrete level information should include both experimentally confirmed and theoretically predicted levels. The utility of discrete level information to optimize level density calculations, to compute isomer ratios, in deriving dipole strength functions, and in the analysis of primary gamma ray spectra is emphasized, especially for nuclei far from the line of stability. 29 refs., 12 figs., 6 tabs. (DWL)

33198 (UCRL—94468) Pre-equilibrium decay processes in energetic heavy ion reactions. Blann, M. (Lawrence Livermore National Lab., CA (USA)). 15 Apr 1986. Contract W-7405-ENG-48. 20p. (CONF-8604165—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009893.

From International conference on heavy ion physics; Rochester, NY, USA (21 Apr 1986).

The Boltzmann master equation (BME) is defined for application to precompound decay in heavy ion reactions in the 10 100 MeV/nucleon regime. Predicted neutron spectra are compared with measured results for central collisions of ^{20}Ne and ^{12}C with ^{165}Ho target nuclei. Comparisons are made with subthreshold π^0 yields in heavy ion reactions between 35 and 84 MeV/nucleon, and with the π^0 spectra. The BME is found to be an excellent tool for investigating these experimentally observed aspects of non-equilibrium heavy ion reactions. 18 refs., 8 figs.

33199 Nuclei far off stability in the N/sub p/N/sub n/ scheme. Casten, R.F. (Brookhaven National Laboratory, Upton, New York, 11973 and University of Koln, Koln, West Germany). *Physical Review* [*Section*] *C: Nuclear Physics;* **33**: No. 5, 1819-1822(May 1986). Contract AC02-76CH00016.

The phenomenological prediction of properties of nuclei far off stability is greatly simplified in the N/sub p/N/sub n/ scheme for three reasons: the systematics for each observable is smooth, the similarity of different regions provides a paradigm for unknown cases and, primarily, the N/sub p/N/sub n/ scheme often transforms the process of extrapolation into one of interpolation. The same ideas find expression in the concept of N/sub p/N/sub n/ multiplets that can link known and unknown nuclei.

33200 **Configuration mixing in preequilibrium reactions: A new look at the hybrid-exciton controversy.** Bisplinghoff, J. (E Division, Lawrence Livermore National Laboratory, Livermore, California 94550 and Institut fuer Strahlen- und Kernphysik, Bonn University, Bonn, Federal Republic of Germany). *Physical Review [Section] C: Nuclear Physics;* **33**: No. 5, 1569-1580(May 1986). Contract W-7405-ENG-48.

The physical concepts of the hybrid and exciton models are reexamined and shown to constitute fundamentally different approaches to preequilibrium reactions. The difference in cross section predictions obtained from the models is not attributable: as has often been argued: to inappropriate exciton distribution functions in higher order terms or multiple chance emission. It rather rests with the question of whether or not configuration mixing is assumed to take place during equilibration and what is assumed about hole interactions. A simplified but realistic example is given to illustrate these points, and a test against experimental data is proposed to decide which model is the more appropriate to use.

33201 **Nuclear vibron model. I. The SU(3) limit.** Daley, H.J.; Iachello, F. (Department of Physics, University of Arizona, Tucson, Arizona 85721). *Annals of Physics (New York);* **167**: No. 1, 73-98(Mar 1986). Contract AC02-76ER03074.

We present a new phenomenological approach to clustering in nuclei. This approach is based on an algebraic treatment of both deformation and clustering. We discuss a particular limit of this model, SU(3), and derive analytic formulas for energies, electromagnetic transition rates, and α-decay widths.

33202 **Meson and Isobar degrees of freedom in nuclear forces.** Vinh Mau, R. (Physics Department, State University of New York at Stony Brook, Stony Brook, New York 11794). *AIP (American Institute of Physics) Conference Proceedings;* **110**: No. 1, 187-206(20 Feb 1984). (CONF-8310245—). Contract AC02-76ER13001.

From Conference on Hadron substructure in nuclear physics; McCormick's Creek S.P., IN, USA (19 Oct 1983).

The current status of the low energy theory of the NN and NN interactions is reviewed, with special attention given to the role of the meson and isobar degrees of freedom. Phenomenology and fits to recent data are also described.

33203 **Transuranium nuclei.** Seaborg, G.T.; Loveland, W.D. (Lawrence Berkeley Lab., Berkeley, CA). pp 255-330 of Treatise on heavy-ion science. Vol. 4: extreme nuclear states. Bromley, D.A. New York, NY; Plenum Press (1984).

The known transuranium elements (TUEs) are presented: Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr, Rf, and Ha. The history of the discovery of those elements mentioned is described. The nuclear properties of TUEs are discussed and fission barrier systematics are listed. Spontaneously fissioning isomers are reviewed and the decay of properties of transuranium nuclei are presented in extensive tables. The chemical and physical properties of TUEs are presented and the use of transuranium targets in heavy-ion reaction studies are revealed. Transuranium reaction products are identified and the synthesis of TUEs is considered.

33204 **Heavy-ion resonances.** Erb, K.A.; Bromley, D.A. (Oak Ridge National Lab., Oak Ridge, TN). pp 201-308 of Treatise on heavy-ion science. Vol. 3: compound system phenomena. Bromley, D.A. New York, NY; Plenum Press (1984).

This paper discusses the influence of the Coulomb barrier resonances and deals with the sharp resonances observed at low energies, particularly in collisions of $^{12}C + ^{12}C$ and $^{12}C + ^{16}O$ nuclei. The authors discuss the gross structure in quasielastic reactions, typified by the broad bumps with widths and spacings of some 4 to 5 MeV which are illustrated in the paper, and then the authors consider its fragmentation into the narrow resonances. A discussion of the qualitatively different, very broad structure seen at the highest energies is presented. Resonances are examined that appear primarily in extreme forward or backward angle data. The energy-dependent structure in fusion yields is examined and resonances in systems with $A \geq 40$ are discussed.

33205 **TDHF calculations of heavy-ion collisions.** Davies, K.T.R.; Devi, K.R.S.; Koonin, S.E.; Strayer, M.R. (Oak Ridge National Lab., Oak Ridge, TN). pp 3-82 of Treatise on heavy-ion science. Vol. 3: compound system phenomena. Bromley, D.A. New York, NY; Plenum Press (1984).

This paper reviews time-dependent Hartree-Fock (TDHF) calculations of heavy-ion collisions with particular emphasis on calculations which can be directly compared with experimental observables. The form of the TDHF equations, the effective interactions used, and the geometrical simplifications invoked in realistic situations are discussed. A compendium and analysis of results for fusion cross sections, deep inelastic collisions, and nonequilibrium emission are given.

33206 **Relativistic heavy-ion collisions: Experiment.** Friedlander, E.M.; Heckman, H.H. (Lawrence Berkeley Lab., Berkeley, CA). pp 403-562 of Treatise on heavy-ion science Vol. 4: extreme nuclear states. Bromley, D.A. New York, NY; Plenum Press (1984).

The authors discuss observables and pseudo-observables in relativistic heavy-ion (RHI) collisions. A review is given of traditional nuclear physics in RHI collisions that precedes a review of particle production in RHI collisions. Available evidence from ultrarelativistic collisions is investigated. This information provides guidelines in choosing observables and experimental techniques for the new envisaged heavy-ion accelerators.

33207 **The use of statistical models in heavy-ion reactions studies.** Stokstad, R.G. (Univ. of California, Berkeley, CA). pp 83-197 of Treatise on heavy-ion science. Vol. 3: compound system phenomena. Bromley, D.A. New York, NY; Plenum Press (1984).

This chapter reviews the use of statistical models to describe nuclear level densities and the decay of equilibrated nuclei. The statistical models of nuclear structure and nuclear reactions presented here have wide application in the analysis of heavy-ion reaction data. Applications are illustrated with examples of gamma-ray decay, the emission of light particles and heavier clusters of nucleons, and fission. In addition to the compound nucleus, the treatment of equilibrated fragments formed in binary reactions is discussed. The statistical model is shown to be an important tool for the identification of products from nonequilibrium decay.

6540 Radiation And Shielding Physics

REFER ALSO TO CITATION(S) 31518, 32249, 32259, 33026, 33290

33208 **(AD-A—164041/6/XAB) Numerical solutions of selected problems which arise in the theory of particle beams. Master's thesis.** Mobley, J.A. (Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering). Dec 1985. 106p. NTIS, PC A06/MF A01.

A previous study led to the development of a closed-form solution to the dynamic behavior of a charged-particle beam. This solution was found for a simple, but nontrivial, single degree of freedom model (the electrostatic approximation model). This thesis investigates the characteristics of this closed-form solution using three different types of inputs. The closed-form solution is then verified by using finite difference to generate compatible results. Also investigated are the characteristics of the dynamic model prior to the implementation of the electrostatic approximation.

33209 **(CEA-N—2449) Non statistical Monte-Carlo.** Mercier, B. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Apr 1985. 32p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751822.

We have shown that the transport equation can be solved with particles, like the Monte-Carlo method, but without random numbers. In our method, particles are created from the original source, with a variable weight taking into account both collision and absorption. These particles are followed until they leave the spatial domain, and we use them to determine a first collision source. Another set of particles is then created from this first collision source, and tracked to determine a second collision source, and

so on. This process introduces an approximation which does not exist in the Monte-Carlo method. However, we have analyzed the effect of this approximation, and shown that it can be limited. Our method is deterministic, gives reproducible results. Furthermore, when extra accuracy is needed in some region, it is easier to get more particles to go there. It has the same kind of applications: rather problems where streaming is dominant than collision dominated problems.

33210 **(CEA-N—2451) Generalized solutions of the radiative transfer equations in a singular case.** Golse, F.; Perthame, B. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Jul 1985. 57p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86751821.

This paper is devoted to the study of the radiative transfer equations (TR). First, we prove a global existence theorem, which allows a blow-up of the opacity σsub(ν(E) when E $\rightarrow$ 0. Thus, it extends Mercier's previous result. This proof relies mainly on a non linear version of Hille-Yosida theorem. Then, we prove the uniqueness of the semigroup solving (TR), and some regularity results (in the class of functions with bounded variation). Finally, we prove the convergence of some splitting algorithms associated to (TR).

33211 **(CEA-N—2461) Steady-state transport equation resolution by particle methods, and numerical results.** Mercier, B. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Oct 1985. 45p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751816.

A method to solve steady-state transport equation has been given. Principles of the method are given. The method is studied in two different cases; estimations given by the theory are compared to numerical results. Results got in 1-D (spherical geometry) and in 2-D (axisymmetric geometry) are given.

33212 **(CEA-N—2465) Steady-state equations of even flux and scattering.** Verwaerde, D. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Nov 1985. 56p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751817.

Some mathematical properties of steady-state equation of even flux are shown in variational formalism. This theoretical frame allows to study the existence of a solution and its asymptotical behavior in opaque media (i.e. the relation with scattering equation). At last it allows to qualify the convergence velocity of resolution iterative processes used practically.

33213 **(CEA-N—2468) Temperature variance study in Monte-Carlo photon transport theory.** Giorla, J. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Oct 1985. 25p. (In French). NTIS (US Sales Only), PC A02/MF A01. File Number DE86751824.

We study different Monte-Carlo methods for solving radiative transfer problems, and particularly Fleck's Monte-Carlo method. We first give the different time-discretization schemes and the corresponding stability criteria. Then we write the temperature variance as a function of the variances of temperature and absorbed energy at the previous time step. Finally we obtain some stability criteria for the Monte-Carlo method in the stationary case.

33214 **(ENEA-RT/ING—82-20) Comparison between different codes for shielding calculations for plutonium transport cask.** Carotenuto, M.I.; Landeyro, P.A.; Pereyra Marcondes, S. (ENEA, Casaccia (Italy). Dipartimento Ciclo del Combustibile; ENEA, Saluggia (Italy). Dipartimento Ciclo del Combustibile). Jul 1982. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901377.

Our group works in safety analysis of fuel cycle plants, in criticality and shielding studies. Today our main problems in the shielding field concern the design of fuel fabrication lines and transport cask for plutonium enriched fuel elements. The first step to consider, before starting the design calculations, is to verify the reliability of existing project codes. For this reason we started a campaign of comparison among different codes, mainly from cost and conservativeness point of view. In normal useage conditions we have three transport codes for neutron shielding calculations: two Monte Carlo ones, MORSE C.G. and TRIPOLI, and a discreet ordinate code, ANISN. Our idea is to take a typical F.B.R. fuel element (PEC) as neutron source and to calculate the strength of dose rate. We consider as shielding materials cylinders of polythene, steel, lead concrete and water, which thickness varies from 5 cm to 30 cm and combinations of these materials. For gamma shielding verification we use the same fuel element as gamma source and the same shielding cylinders used in neutronic computations. In this case they are performed with ANISN and MERCURE-4. The different codes results are in reasonable agreement. The difference existing between MORSE C.G. surface dose and TRIPOLI one is practically comprised in the range of statistical error sum in all cases. The difference between these results and those of ANISN is due to the infinite configuration considered in ANISN modelling. The results also show good agreement between calculations realized with different cross-section libraries. From the cost point of view, of course the most convenient is the ANISN code. TRIPOLI calculations are quite cheap, but this code has the disadvantage of its limitation in the cross-section library. For the gamma dose calculations the agreement between ANISN and MERCURE-4 results is good.

33215 **(IAE—3938/9) Angular dependence of photo-emf on X-ray diffraction in ideal crystals of semiconductors with p-n junction.** Zheludeva, S.I.; Koval'chuk, M.V.; Kon, V.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 28p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86701940.

The results of experimental and theoretical investigation of EMF angular dependence arising under the conditions of X-ray dynamical diffraction in crystals of semiconductors with p-n junction are presented. The cases of diffraction in Bragg geometry as well as Lane geometry in samples with p-n junctions at the inlet and outlet crystal surfaces are considered. In the case of diffraction in Bragg geometry, a strong dependence of EMF curve shape from d thickness of upper n-region at d > Lsub(ex), where Lsub(ex) is extinction length, has been found. The general form of influence function p(z) describing a contribution into EMF of electrons born in the crystal volume at the z depth is derived. A detailed theoretical analysis of influence on the EMF angular dependence shape of diffraction parameters as well as electrophysical, such as diffusion lengths of minority charge carriers in p- and n-regions. Experimental curves are in perfect agreement with calculational ones performed on the base of a developed theory.

33216 **(IAE—4019/11) Vacancy spatial redistribution in damage cascade area at stage of thermal peak.** Kapinos, V.G. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 29p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86701941.

Certain possible mechanisms of vacancy redistribution in the damage cascade area (DCA) at the stage of thermal peak (TP) have been considered. The character of the melting of the crystallite microscopic volume with the structure of a DCA depleted area is studied. Simulation of migration of the minor vacancy complex, using the method of molecular dynamics (MMD), is realized and its diffusion characteristics are determined. It is shown, that in TP the drift of migrating vacancies over temperature gradient will be observed. Quantitative evaluation of the observed effect of vacancy and divacancy thermodiffusion is made.

33217 (INIS-BR—462, pp 194-197) **Helium release from metals with face-centered cubic structure.** Sciani, V.; Lucki, G.; Jung, P. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, Brazil; Kernforschungsanlage Juelich G.m.b.H., Germany, F.R. Inst. fuer Festkoerperforschung). 1984. (In Portuguese). NTIS (US Sales Only), PC A17/MF A01. File Number DE86702009. (CONF-8412102—).

From 6. Brazilian congress on engineering and materials science; Rio de Janeiro, Brazil (9 Dec 1984).

The helium release from gold sheets of 5 and 54 μm of thickness and helium concentrations from 10^{-9} to 10^{-5} ap of He during the isothermal and linear annealing is studied. The helium was put in the sample through the implantation of alpha particles,

with variable energy, in the cyclotron. The free diffusion of the atoms of the helium, where the diffusion coefficient follows an Arrhenius law is studied.

33218 **(INIS-mf—10110) Application of Monte Carlo method in modelling physical and physico-chemical processes. Seminar proceedings.** (Ceske Vysoke Uceni Technicke, Prague (Czechoslovakia). Fakulta Jaderna a Fysikalne Inzenyrska). 1984. 71p. (In Czech). (CONF-8209296—). NTIS (US Sales Only), PC A04/MF A01. File Number DE86701972.

From Conference on application of Monte Carlo method in modelling physical and physico-chemical processes; Prague, Czechoslovakia (9 Sep 1982).

The seminar was held on September 9 and 10, 1982 at the Faculty of Nuclear Science and Technical Engineering of the Czech Technical University in Prague. The participants heard 11 papers of which 7 were input in INIS. The papers dealt with the use of the Monte Carlo method for modelling the transport and scattering of gamma radiation in layers of materials, the application of low-energy gamma radiation for the determination of secondary X radiation flux, the determination of self-absorption corrections for a 4π chamber, modelling the response function of a scintillation detector and the optimization of geometrical configuration in measuring material density using backscattered gamma radiation. The possibility was studied of optimizing modelling with regard to computer time, and the participants were informed of computerized nuclear data libraries.

33219 (INIS-SU—325, pp 26-34) **Reflection of ultracold neutrons from strongly absorbing media.** Golikov, V.V.; Kulagin, E.N.; Nikitenko, Yu.V. 1985. (In Russian). NTIS (US Sales Only), PC A04/MF A01. File Number DE86780459.

In JINR rapid communications. Collection.

The results are reported of the study of ultracold neutron (UCN) reflection from strongly absorbing samples of natural cadmium and of cadmium enriched with ^{113}Cd isotope up to 95%. The experimental data are well described in the framework of the theory of UCN reflection which uses the complex reflection index for the refraction of neutron waves. It follows from theoretical analysis that for the natural mixture of cadmium isotopes having a positive scattering length the neutron capture by cadmium reduces the UCN reflection index. On the contrary, if the scattering length is negative, as it is for ^{113}Cd, the neutron capture increases the reflection index. Experimental data are in agreement with calculated results if the oxide film on the cadmium surface is taken into account.

33220 **(JINR—R-14-84-429) Excitation cross section of characteristic X-ray radiation by protons and ^{4}He ions for elements with Z within 22 <= Z <= 83 range.** Brazevich, Eh.; Brazevich, Ya.; Volkof, V.F.; Gerasimov, S.A.; Lyu Zaj Ik; Osetinskij, G.M.; Purehv, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1984. 11p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701942.

Submitted to the journal Sov. J. At. Energy.

Experimental results on the determination of characteristic X radiation (CXR) yield cross section from K- and L-shells during excitation of various elements by a beam of protons and ^{4}He ions are presented. The investigations are carried out using 18 elements with z in the range 22 <=z <= 83 and in the energy range 1.5-3.8 MeV.

33221 **(JINR—R-17-84-371) Electronic stopping power formula for energetic ions.** Bardosh, D.; Gavrilenko, G.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1984. 6p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701932.

Submitted to the journal Acta Phys. Hung. .

Electronic stopping power has been calculated for H, He, Li, C, O, Mg and Si ion projectiles in Al, Ni, Ag and Au substrates. Ion energies range from 0.2 MeV/amu to 30 MeV/amu. The stopping power formula has been expressed as the sum of a modified Bethe formula and a modified Lindhard-Scharff-Schiott (LSS) formula. In both formulas effective charges have been applied, which were computed on the basis of universal electronic density suggested Gaspar.

33222 **(MPQ—97) Integrating box for laser-plasma reflectivity studies.** Foeldes, I.B.; Bayerl, J.; Sachsenmaier, P.; Sigel, R. (Max-Planck-Institut fuer Quantenoptik, Garching (Germany, F.R.)). Jun 1985. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86752018.

An integrating box was constructed for laser-plasma reflectivity measurements. After careful calibration it proved to be a useful instrument which can be applied simultaneously together with other diagnostics. Measurements with gold and copper targets at different laser wavelengths prove its applicability to laser-plasma interaction studies. (orig.).

33223 **(RAL—85-074) Studies of the dynamic properties of materials using neutron scattering.** Lovesey, S.W.; Windsor, C.G. (Rutherford Appleton Lab., Chilton (UK); UKAEA Atomic Energy Research Establishment, Harwell. Materials Physics Div.). Sep 1985. 54p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86701939.

The dynamic properties of materials using the neutron scattering technique is reviewed. The basic properties of both nuclear scattering and magnetic scattering are summarized. The experimental methods used in neutron scattering are described, along with access to neutron sources, and neutron inelastic instruments. Applied materials science using inelastic neutron scattering; rotational tunnelling of a methyl group; molecular diffusion from quasi-elastic scattering; and the diffusion of colloidal particles and poly-nuclear complexes; are also briefly discussed.

33224 **Multigroup transport equations with nondiagonal cross-section matrices.** Willis, B.L.; van der Mee, C.V.M. (Center for Transport Theory and Mathematical Physics, Virginia Polytechnic Institute; State University, Blacksburg, Virginia 24061). *Journal of Mathematical Physics (New York);* 27: No. 6, 1633-1638(Jun 1986). Contract AS05-80ER10711.

Multigroup transport equations with nondiagonal cross-section matrices are studied using the Wiener-Hopf method. Formulas for the solution and the exit distribution are given in terms of the factorization of the symbol of the Wiener-Hopf equation. Unlike the formulas for a diagonal cross-section matrix, these formulas involve derivatives of the H-functions. For the case of two groups, the H-functions are computed explicitly.

33225 **Theoretical investigation of neutron scattering cross sections in Si and Ge.** Morgan, T.; Blackman, J.A.; Cooke, J.F. (Physics Department, University of Reading, Reading, England). *Physical Review* [*Section*] *B: Condensed Matter;* 33: No. 10, 7154-7159(15 May 1986). Contract AC05-84OR21400.

The development of high-flux high-energy pulsed neutron sources makes it possible to study electronic transitions in solids which are in the electron-volt range. A theoretical study has been carried out to determine the feasibility of using such sources to obtain information about the band structure of semiconductors. Calculations of the inelastic neutron scattering cross sections for germanium and silicon based on an empirical pseudopotential description of the energy bands have been com- pleted. This study is an extension of previous work to more realistic (larger) momentum transfers. The calculated cross sections were found to be quite small for realistic experimental conditions. Measurement of these relatively small cross sections could, however, provide important information about the band structure of semiconductors which cannot be obtained from most other experimental techniques.

33226 **Rainbow effect in ion channeling.** Nekovic, N. (Boris Kidri Institute of Nuclear Sciences, 11001 Belgrade, Yugoslavia; Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830). *Physical Review* [*Section*] *B: Condensed Matter;* 33: No. 9, 6030-6035(1 May 1986). Contract W-7405-ENG-26.

The problem of ion channeling in very thin crystals is considered with use of a method of classical ion-molecule scattering theory complemented with the Monte Carlo method. Special atten-

tion is devoted to the rainbow effect. It is shown that this effect is a consequence of the fact that contributions of the atomic strings of the crystal to the probability of ion transmission interfere. In the calculations the projectiles were 7-MeV H^+ ions, and they were being transmitted through the <110> channel of a 21500-A-thick Si crystal; the case in which the incident energy is 10 MeV and crystal thickness 21000 A is also analyzed. The effect of thermal vibrations of the atoms of the crystal and the effect of collisions of the ion with the electrons of the crystal are taken into account.

33227 **Rainbow effect in axial ion channeling.** Krause, H.F.; Datz, S.; Dittner, P.F.; Gomez del Campo, J.; Miller, P.D.; Moak, C.D.; Nekovic, N.; Pepmiller, P.L. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review [Section] B: Condensed Matter;* **33**: No. 9, 6036-6044(1 May 1986). Contract AC05-84OR21400.

We have studied the angular scattering distributions produced in axial channeling when incident protons (7 MeV) are well aligned to the axial direction of a thin silicon crystal (1400 A). Measured angular distributions obtained in the <100> and <110> directions using a two-dimensional (2D) position-sensitive detector (resolution < or $\approx 0.015^{\circ}$) have been interpreted by comparison with Monte Carlo trajectory calculations for these channels in the momentum approximation. The measured angular distributions show structures at certain off-axis angles which are in good agreement with the calculations. The general shape and structure in the angular contour map for a given channel have been shown to be a consequence of extrema in the 2D classical deflection functions for the two Cartesian scattering angles in the detection plane. The occurrence of the extrema in a very thin crystal (i.e., a rainbow effect in axial channeling) is a consequence of the channeling geometry when atomic strings surrounding the axial channel interact with the projectile simultaneously.

33228 **Multigroup Legendre coefficients for the diamond difference continuous slowing down operator.** Morel, J.E. (Los Alamos National Laboratory, Applied Theoretical Physics Division, Los Alamos, NM). *Nuclear Science and Engineering;* **91**: No. 3, 324-331(Nov 1985).

A set of multigroup Legendre coefficients is derived that can be used to implement the diamond difference scheme for the continuous slowing down operator in standard (unmodified) S /sub n/ codes. Calculations are performed that demonstrate the validity of these coefficients, and the superior accuracy of the diamond difference scheme relative to the standard first-order multigroup method.

33229 **Improvements in calculating neutron transmission probabilities in unit-cell interface-current codes.** Worley, B.A. (Oak Ridge National Laboratory, Oak Ridge, TN). *Nuclear Science and Engineering;* **91**: No. 3, 293-304(Nov 1985).

A standard assumption used in unit-cell interface-current codes is that neutrons enter each spatial region with an isotropic angular distribution. The physical interpretation of this assumption is discussed, and the magnitude of the error introduced by it is shown for a range of practical unitcell geometries. An improvement on the calculation of first-flight transmission probabilities for onedimensional unit cells based on limiting the neutron source angular distribution to physically possible neutron flight directions is then presented. For three-region problems, one additional calculation of a revised outer region transmission probability is sufficient for determining all the revised transmission probabilities of interest. Calculation of the revised transmission probabilities requires only minor coding changes and eliminates the improper angular redistribution of neutrons at the region boundaries.

6550 Medical Physics

REFER ALSO TO CITATION(S) 31904, 32619, 32632, 32832, 32833

33230 **(INIS-mf—10121) Guide for controlling consumer products containing radioactive substances.** (Nuclear Energy Agency, 75 - Paris (France)). 1985. 31p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86702029.

Also published in French.

Consumer products are considered regardless of the purpose for which the radionuclide is added. For example, the purpose may be to make use of the ionising radiation emitted by the substance in the product itself (e.g. radioluminescent devices, antistatic devices and ionisation chamber smoke detectors), or to make use of some other property of the material where the presence of radiation in the final product is merely adventitious (e.g. thorium gas mantles, ceramics with uranium glazes, and products containing radioactive tracers added to facilitate manufacturing and inspection processes). The guide does not cover some products containing natural radioactive substances which have not been intentionally added, such as building materials. The guide does not cover medicinal products and pharmaceuticals, nuclear powered cardiac pacemakers, or electronic equipment, such as television receivers, that emit X-rays. Unlike the 1970 guide, this guide does not consider those products, such as EXIT signs, containing gaseous tritium light sources, that would not be supplied directly to members of the public. The guide is concerned mainly with the exposure arising from consumer products of those persons who are not subject to any regulatory controls for purposes of radiation protection in normal circumstances. Members of the public come under this heading, but not workers involved in the manufacture of consumer products. These workers will normally be subject to separate control. Radiological protection concepts and policy for the control of radioactive consumer products and licensing and post-licensing surveillance are developed.

33231 **(INIS-mf—10122) Metrology and monitoring of radon, thoron and their daughter products.** (Nuclear Energy Agency, 75 - Paris (France)). 1985. 148p. NTIS (US Sales Only), PC A07/MF A01. File Number DE86702030.

Also published in French.

The principles of measurement and monitoring are described as applied to radon and thoron gases and their daughter products in occupational and non-occupational environments. Various methods of measurement, such as grab-sampling, continuous monitoring, integrated measurements and personnel dosimetry are discussed. Uncertainties in different measurement methods are compared. An account of unattached fraction and plateout of radon daughters is included. General principles and guidelines for monitoring are presented for the purposes of practical radiation protection as well as research applications. Calibration aspects of measurement instruments are described and procedures for interlaboratory calibration are suggested. Sampling strategies for occupational and non-occupational environments are discussed and radiation protection training requirements are identified. Where sufficient information and consensus exist, guidelines on apparatus, methods and procedures for monitoring are provided. A summary of regulations in force or being developed and recommendations for monitoring radiation exposure to radon and its decay products in countries of the OECD is provided, together with cost estimates for national indoor radon surveys.

33232 (PNL-SA—13346, pp 18-24) **Litigation, standards and impact.** Vallario, E.J. (Dept. of Energy, Washington, DC). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

Litigation and its implications to radiation protection will probably create the greatest pressure to enhance radiation protection instrumentation performance in the next few years. Areas of improvement such as accuracy, precision, sensitivity, and the upgrade of instrumentation that will require careful consideration on the part of the manufacturer and operational health physicist are discussed.

33233 (PNL-SA—13346, pp 25-29) **Legislation and litigation related to low-level radiation injury claims.** McCraw, T. (Dept. of Energy, Washington, DC). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

Current legislation and litigation related to radiation exposure will have an enormous impact on the radiation protection and

monitoring requirements of the future. A brief review of some proposed injury compensation bills for veterans and a recent court decision for low-level radiation injury claims are reviewed.

33234 (PNL-SA—13346, pp C.2-C.5) **Interagency Committee on Occupational Radiation Protection Measurements.** Eisenhower, E.H. (National Bureau of Standards, Gaithersburg, MD). Nov 1985. NTIS, PC A20/MF A01. File Number DE86005525. (CONF-840774—).

From Workshop on radiation survey instruments and calibrations; Gaithersburg, MD, USA (10 Jul 1984).

The Interagency Committee on Occupational Radiation Protection Measurements is a group of government agency representatives who have a common concern about the quality of measurements of ionizing radiation. The Committee is interested in finding solutions for such operational problems and in the development of national programs that will assure adequate measurement quality. It was the existence of problems in a particular area of measurement, and the need for acceptable solutions that resulted in creation of the Committee. When the Conference of Radiation Control Program Directors identified problems with the accuracy and reliability of personnel dosimetry services in 1973, it created a task force to investigate possible methods for developing a performance testing program. Following usual Conference policy and procedures, it invited interested federal agencies to appoint resource persons to the task force. The committee members, functions of the committee, and activities of the committee are presented.

6560 Solid-state Physics

REFER ALSO TO CITATION(S) 32450, 33093, 33282

33235 **(CBPF-NF—060/85) Enhancement of surface magnetism due to bulk bond dilution.** Tsallis, C.; Sarmento, E.F.; Albuquerque, E.L. de. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro; Alagoas Univ., Maceio (Brazil). Dept. de Fisica; Rio Grande do Norte Univ., Natal (Brazil). Dept. de Fisica). 1985. 14p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701934.

Within a renormalization group scheme, the phase diagram of a semi-infinite simple cubic Ising ferromagnet is discussed, with arbitrary surface and bulk coupling constants, and including possible dilution of the bulk bonds. It is obtained that dilution makes easier the appearance of surface magnetism in the absence of bulk magnetism.

33236 **(NORDITA—84/33-Prepr.) Renormalization theory for spin glasses based on eigenstates of the J matrix.** Hertz, J.A. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). Oct 1984. 22p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751765.

We propose a renormalization scheme for spin glasses based on localized clusters associated with the eigenstates of the exchange matrix. These clusters are chosen as the block spins of the renormalization procedure and their interactions estimated. The interaction matrix of this new spin glass problem is then diagonalized to find clusters of clusters, and so on. The simplest estimate of the interactions predicts a phase transition for $d>2$. The successive levels of slow modes or clusters provide a direct description of the relevant metastable states and spin dynamics on a hierarchy of time scales. (orig.).

33237 **(NORDITA—84/40-Prepr.) Parisi function for two spin glass models.** Sibani, P.; Hertz, J.A. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark)). 1984. 58p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86751764.

The probability distribution function P(q) for the overlap of pairs of metastable states and the associated Parisi order function q(x) are calculated exactly at zero temperature for two simple models. The first is a chain in which each spin interacts randomly with the sum of all the spins between it and one end of the chain; the second is an infinite-range limit of a spin glass version of Dyson's hierarchical model. Both have nontrivial overlap distributions: In the first case the problem reduces to a variable-step-length random walk problem, leading to $q(x)=\sin(\pi x)$. In the second model P(q) can be calculated by a simple recursion relation which generates devil's staircase structure in q(x). If the fraction p of antiferromagnetic bonds is less than $1/\sqrt{2}$, the staircase is complete and the fractal dimensionality of the complement of the domain where q(x) is flat is log 2/log $(1/p^2)$. In both models the space of metastable states can be described in terms of Cayley trees, which however have a different physical interpretation than in the S.K. model. (orig.).

33238 **(SAND—85-2411C) Chemical reaction in shock compression of solids.** Graham, R.A.; Morosin, B.; Horie, Y.; Venturini, E.L. (Sandia National Labs., Albuquerque, NM (USA); North Carolina State Univ., Raleigh (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-860616—8). NTIS, PC A02/MF A01; GPO Dep. File Number DE86003502.

From International symposium on intense dynamic loading and its effects; Beijing, China (3 Jun 1986).

The study of shock induced solid state chemistry is presented. Shock modification and chemical reaction were studied by various material probes. The BET method was used to determine the specific surface area. Computerized analysis of scanning electron microscope photographs determined the particle size distribution. Other material probes such as x-ray diffraction, electron spin resonance, transmission electron microscopy, thermal analysis with differential scanning calorimetry and differential thermal analysis as well as optical microscopy were used. 23 refs.

33239 **Wave vector dependent susceptibility of a free electron gas in D dimensions and the singularity at 2k/sub F/** . Sharma, N.L.; Lee, M.H. (Department of Physics, University of Georgia, Athens, Georgia 30602). *Journal of Mathematical Physics (New York);* **27**: No. 6, 1618-1623(Jun 1986).

The static susceptibility of a free electron gas in D dimensions at $T = 0$ is obtained by techniques of dimensional regularization. Our solutions for the susceptibility chi(k,D) are given in terms of the hypergeometric function. For any integer dimensions analytic expressions are possible. The high- and low-k series solutions are shown to be related by an analytic continuation if D is an odd integer, but not related if D is an even integer. The singularity at 2k/sub F/ is a branch point, whereupon the series solutions are absolutely convergent, yielding chi(k = 2k/sub F/,D) = $(D-1)^{-1}$. The relationship of chikD has the appearance of a PVT diagram.

33240 **Noise-driven sidebranching in the boundary-layer model of dendritic solidification.** Pieters, R.; Langer, J.S. (Physics Department, University of California, Santa Barbara, California 93106). *Physical Review Letters;* **56**: No. 18, 1948-1951(5 May 1986). Contract FG03-84ER45108.

We suggest that dendritic sidebranches may, under some circumstances, be generated by selective amplification of noisy fluctuations near the tip. Our proposal is based on numerical and analytic studies of the dynamics of the two-dimensional boundary-layer model with kinetic crystalline anisotropy. Certain features of this stochastic process should make it experimentally distinguishable from a deterministic, dynamical sidebranching mechanism.

33241 **Anderson localization and breakdown of hydrodynamics in random ferromagnets.** Bruinsma, R.; Coppersmith, S.N. (Physics Department, University of California, Los Angeles, Los Angeles, California 90024). *Physical Review [Section] B: Condensed Matter;* **33**: No. 9, 6541-6544(1 May 1986). Contract AC02-76CH00016.

The dynamic structure factor of Heisenberg magnets with weak randomness is computed. Under circumstances which are explained in detail, we find failure of hydrodynamic theory in the longitudinal structure factor due to localization of spin waves. Localization induces a power-law dependence on q and ω for the neutron scattering line shape near magnetic Bragg spots. The exponent describing the power law is related to the correlation-length exponent of Anderson localization. Random anisotropy magnets appear to be promising candidates for experimental investigations.

33242 **Thermodynamic properties of a three-dimensional defect system.** Janke, W.; Kleinert, H. (Institut fuer Theorie der Elementarteilchen, Freie Universitaet Berlin, Arnimallee 14, D-1000 Berlin 33, Germany). *Physical Review [Section] B: Condensed Matter;* **33**: No. 9, 6346-6351(1 May 1986). Contract AS03-81ER40029.

We analyze the recently proposed model of defect melting in three dimensions via high- and low-temperature expansions and compare the internal energy and specific heat with the result of Monte Carlo simulations. The transition is found to be strongly of first order with a Lindemann number L>112 and a transition entropy Δs roughly-equal 1.2, thus very much resembling a crystalline melting process.

33243 **Exact renormalization group for dynamical phase transitions in hierarchical structures.** Maritan, A.; Stella, A.L. (Dipartimento di Fisica, Istituto Nazionale di Fisica Nucleare, Universita di Padova, Italy). *Physical Review Letters;* **56**: No. 16, 1754-1754(21 Apr 1986). Contract FG05-84ER45071.

A Comment on the Letter by S. Teitel and E. Domany, Phys. Rev. Lett. 55, 2176 (1985).

33244 **Multiple-scattering theory for clusters of nonoverlapping potentials of arbitrary shape.** Gonis, A. (Department of Physics and Astronomy, Northwestern University, Evanston, Illinois 60201). *Physical Review [Section] B: Condensed Matter;* **33**: No. 8, 5914-5916(15 Apr 1986). Contract FG02-84ER45080.

It is shown that the full scattering matrix associated with an assembly of nonoverlapping potentials of arbitrary convex shape has precisely the same form as the corresponding expression for potentials confined inside nonoverlapping spheres. A specific implication of this result is that the electronic structure of periodic solids can be obtained from the solutions of a secular equation formally identical to that of the Korringa-Kohn-Rostoker method for periodic muffin-tin potentials.

6561 Superconductivity

REFER ALSO TO CITATION(S) 32172, 32204, 32222, 32238, 32240, 32436

33245 **(CONF-8509232—2) Josephson oscillations of charge density waves.** Ruvalds, J.; Tua, P.F. (Virginia Univ., Charlottesville (USA). Dept. of Physics). 1985. Contract FG05-84ER45113. 13p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010320.

From Conference on Josephson effect: achievements and trends; Torino, Italy (16 Sep 1985).

The formation of charge density waves in solids was originally proposed as a possible mechanism for superconductivity by Froehlich. Although the experimentally discovered materials with charge density waves (CDW)s are found to have finite resistivity as a result of impurity pinning, they nevertheless reveal many interesting features including motion which is analogous to a resistively shunted Josephson junction of superconductors. The noise spectrum of CDW systems is reviewed with particular emphasis on interactions with normal as well as magnetic impurities. Future prospects for observing an amplitude variation of the noise signals induced by a magnetic field are proposed.

33246 **(NORDITA—84/42-Prepr.) On the derivation of quasi-classical equations for superconductors or ^{3}He.** Shelankov, A.L. (Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark); AN SSSR, Leningrad. Fiziko-Tekhnicheskij Inst.). Nov 1984. 30p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751766.

We present a method for the derivation of the quasi-classical equations for Keldysh Green function of a superconductor or superfluid ^{3}He. It is shown that Green functions on the classical trajectories $g(Y_1,Y_2)$ which depend on two trajectory coordinates y_1 and y_2, give the full description of the system within quasi-classical accuracy. The equation of motion for $g(y_1,y_2)$ is obtained. it is shown that $g(y)=g(y+0,y)+g(y-0,y)$ is equal to the Green function in momentum space integrated with respect to xi=vsub(F)(psub(F)). The normalization condition $(g(y))^2=1$ is proved in a direct manner using the properties of $g(y_1,y_2)$ with $y_1$not$=Y_2$. The different methods of introducing the distribution function are discussed. (orig.).

6570 Theoretical Physics

REFER ALSO TO CITATION(S) 32410, 32908, 33026, 33076, 33084, 33085, 33284, 33289

33247 **(CBPF-NF—068/85) Spin-two equations.** Silveira, A. da. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). 1985. 8p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701916.

Transformations that maintain invariant the spin-two equation presented by Galles are considered.

33248 **(CEA-N—2445) Some high resolution numerical schemes for hydrodynamic equation integration.** Desgraz, J.C. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Jun 1985. 81p. (In French). NTIS (US Sales Only), PC A05/MF A01. File Number DE86751819.

We present here some high resolution schemes for gas dynamical simulations in on space dimension. In case of Eulerian coordinates the schemes are formulated as a lagrangian step followed by a remap. We insist on numerical results.

33249 **(CEA-N—2460) Implicit adaptative method of mesh generation for hydrodynamic equations.** Perthame, B. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Oct 1985. 48p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751820.

Hydrodynamic problem is resolved in an implicit manner with a first order scheme coupled to equations which define mesh generation. This allow us to follow more precisely solution discontinuities.

33250 **(CEA-N—2466) Comparison of different numerical schemes for integration of hydrodynamic equations with Lagrange coordinates.** Desgraz, J.C. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Nov 1985. 48p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751818.

Results given by three numerical schemes for some problems whose analytical solution is given are compared. These three schemes are: - the Richtmyer scheme, - the PPM scheme, - the T.V.D. scheme. A variation of this last one, aimed at reducing phase error, is presented.

33251 **(CEA-R—5330) 1-D equations of radiation hydrodynamics.** Munier, A. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Nov 1985. 37p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751811.

The radiation transfer equation is derived in the comoving frame, in curvilinear coordinates, to first order in u/c, no symmetry being assumed. This equation is then specialized to 1-D, and its moments are calculated for the limiting case of Thomson scattering. The equations of radiation hydrodynamics are also given.

33252 **(CERN—85-17) Tribute to Niels Bohr.** (European Organization for Nuclear Research, Geneva (Switzerland)). 13 Nov 1985. 19p. (CONF-8505255—1). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701917.

From Special colloquium: a tribute to Niels Bohr; Geneva, Switzerland (6 May 1985).

This report is organized around the contribution of A. Pais, 'Niels Bohr and the development of physics', presented at CERN on the occasion of a special colloquium in the honour of Niels Bohr. It gives a broad survey of Bohr's life, the revolution in physics created by his quantum theory and his attempts to influence the peaceful development of nuclear energy.

33253 (INIS-SU—320, pp 284-295) **Summation of asymptotic expansions: the gxsup(2N)-anharmonic oscillator.** Ilchev, A.S.; Mitryushkin, V.K. (Joint Inst. for Nuclear Research, Dubna, USSR). 1984. NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

A new technique for summing up divergent but Borel-summable series is proposed. It is argued that the Borel transform, when suitably defined to be free from singularities in the finite complex plane, can mimic the asymptotic behaviour of the underlying function and that a finite number of terms are sufficient to probe this behaviour. This possibility offers arguments in favour of considering modified Borel transformations which lead to a certain entire function as the Borel transform of the divergent series under study. The unavoidable approximation of the Borel transform is a much easier task for such functions because it is no longer necessary to perform an analytic continuation. The absolute values of the first several coefficients Asub(K) for N=2, ..., 5 are tabulated. Their numbers correspond to the quartic (N=2) anharmonic oscillator.

33254 (INIS-SU—320, pp 296-308) **Integrals of motion and symmetry of quantum systems.** Man'ko, V.I. 1984. (In Russian). NTIS (US Sales Only), PC A16/MF A01. File Number DE86780457. (CONF-8307163—Vol.2).

From 6. international seminar on high energy physics and quantum field theory; Protvino, USSR (1 Jul 1983).

Two notions: a) motion integral of a physical system, b) physical system symmetry - are analyzed and the relation of these notions is elucidated. The consideration is performed within the framework of quantum systems described with the Schroedinger equation although it is true also for classical systems and for relativistic systems described with the Dirac equation, for example. It was proved that motion integrals and the Green function are connected with each other by a series of relations. The Green function in the coordinate representation is the eigenvalue solution of a set of equations.

33255 (INIS-SU—321, pp 48-56) **On superspinor structure of homogeneous superspace of orthosymplectic groups.** Volkov, D.V.; Soroka, V.A.; Tkach, V.I. 1984. (In Russian). NTIS (US Sales Only), PC A19/MF A01. File Number DE86780458. (CONF-8407160—Vol.1).

From 7. seminar on problems of high energy physics and quantum field theory; Protvino, USSR (1 Jul 1984).

Superspinor structure of homogeneous superspaces of orthosymplectic groups are considered. It is shown how the properties of orthosymplectic group superspaces of OSp(N, 2K) group playing an important role in the supersymmetry theory can be described using superspinors. An example confirming a possibility of the relation between canonical ratios of Butten bracket and conventional methods of quantization is considered.

33256 (IPNO-DRE—85-10) **Some properties of the functions satisfying Bell's inequalities in relation to quantum mechanics.** Roussel, P. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). 1985. 46p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751805.

Having recalled the 1935 debate between A. Einstein and N. Bohr about quantum mechanics (Q.M.) the thought-experiment of D. Bohm is described and a new derivation of the Bell's inequalities is established to test the class of theories based on the hypothesis of hidden-parameters in the common past. It is shown that Q.M. violates these inequalities almost everywhere. The general properties of functions satisfying Bell's inequalities are studied in order to compare them to Q.M. predictions as regards derivatives, integrals, values, intervals, amplitudes and finally the overall behaviour: a few of the Bell's functions chosen to approach somehow Q.M. are given. Altogether, in the comparison between Q.M. and functions satisfying Bell's inequalities, an incompatibility is revealed that is stronger then that resulting from consideration of just the inequalities.

33257 (IPNO-TH—85-11) **Semiclassical approach to Dirac operators in the ground state wave function representation.** Gamonal, R. (Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire). Mar 1985. 11p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86751804.

We show that for the class of gauge field configurations which reduce the Dirac operator to the one-dimensional Witten's hamiltonian, an appropriate semiclassical quantization rule permits the computation, of the bound state spectrum in an accurate way.

33258 (LA-UR—86-1238) **Real time quantum dynamics in the Heisenberg picture.** Cooper, F. (Los Alamos National Lab., NM (USA); Boston Univ., MA (USA). Dept. of Physics). 1986. Contract W-7405-ENG-36. 15p. (CONF-860288—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010177.

From 4. symposium on current trends in physics; Bhubaneswar, India (24 Feb 1986).

In order to understand dynamics in the Heisenberg picture, a study is made of ordinary single particle quantum mechanics where the methods used can be compared with solving the Schroedinger equation numerically. The methods are generalized to field theory. Both analytic and numerical strategies are developed for solving the Heisenberg equations on a time lattice. The time development of an initial gaussian wave function is considered in various potentials in order to study both quantum tunnelling phenomena and the quantum roll. 9 refs., 1 fig. (LEW)

33259 (LA-UR—86-1262) **Time-dependent variational principle for quantum dynamics in the Schrodinger-picture.** Cooper, F.; Pi, S.Y. (Los Alamos National Lab., NM (USA); Boston Univ., MA (USA). Dept. of Physics). 1986. Contract W-7405-ENG-36. 18p. (CONF-860288—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010179.

From 4. symposium on current trends in physics; Bhubaneswar, India (24 Feb 1986).

Starting with the exact variational formulation of quantum mechanics (or quantum field theory) in the Schroedinger picture, and using Gaussian trail wave functions, an exact functional Schroedinger equation is obtained. The time-dependent Hartree-Fock approximation is obtained and extended to many oscillators and to field theory. The problem of quantum roll, in which an initial Gaussian wave packet starting at an unstable classical equilibrium point evolves in time, is treated using this formalism. Quantum tunnelling is also studied. (LEW)

33260 (LBL—20833-Rev.) **Optical systems for synchrotron radiation. Lecture 1. Introductory topics. Revision.** Howells, M.R. (Lawrence Berkeley Lab., CA (USA)). Feb 1986. Contract AC03-76SF00098. 20p. (CONF-8509255—2-Rev.). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009906.

From Synchrotron radiation sources and their applications conference; Aberdeen, Scotland (14 Sep 1985).

Various fundamental topics are considered which underlie the design and use of optical systems for synchrotron radiation. The point of view of linear system theory is chosen which acts as a unifying concept throughout the series. In this context the important optical quantities usually appear as either impulse response functions (Green's functions) or frequency transfer functions (Fourier Transforms of the Green's functions). Topics include the damped harmonic oscillator, free-space optical field propagation, optical properties of materials, dispersion, and the Kramers-Kronig relations.

33261 (LBL—20835-Rev.) **Optical systems for synchrotron radiation. Lecture 3. Monochromator systems. Revision.** Howells, M.R. (Lawrence Berkeley Lab., CA (USA)). Feb 1986. Contract AC03-76SF00098. 17p. (CONF-8509255—3-Rev.). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009905.

From Synchrotron radiation sources and their applications conference; Aberdeen, Scotland (14 Sep 1985).

General properties of monochromators are discussed, and some useful formulas for optical design are given. The discussion is

limited to the Rowland reflection grating. Topics covered include focussing properties of a toroidal grating, aberrations, dispersion, resolution, and phase space acceptance. (LEW)

33262 **(LCC—032/85) On convergence of nuclear and correlation operators in Hilbert space.** Kubrusly, C.S. (Laboratorio de Computacao Cientifica, Rio de Janeiro (Brazil)). 1985. 25p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701918.

The convergence of sequences of nuclear operators on a separable Hilbert space is studied. Emphasis is given to trace-norm convergence, which is a basic property in stochastic systems theory. Obviously trace-norm convergence implies uniform convergence. The central theme of the paper focus the opposite way, by investigating when convergence in a weaker topology turns out to imply convergence in a stronger topology. The analysis carried out here is exhaustive in the following sense. All possible implications within a selected set of asymptotic properties for sequences of nuclear operators are established. The special case of correlation operators is also considered in detail.

33263 **(ORNL—6216) Hyperbolic Stefan problem with discontinuous temperature.** Solomon, A.D.; Alexiades, V.; Wilson, D.G.; Greenberg, J. (Maryland Univ., Baltimore (USA). Dept. of Mathematics; Oak Ridge National Lab., TN (USA)). Mar 1986. Contract AC05-84OR21400. 22p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010069.

In an earlier paper a Stefan problem for hyperbolic heat transfer was formulated under the condition of continuity of the temperature at the moving front. In this paper this assumption is examined and an alternative model is presented in which continuity is not imposed. For this case, a problem with an explicit solution is presented, as are some qualitative properties of solutions to some similar problems. In addition, quasi-steady approximate solutions to certain other benchmark problems are derived. 5 refs.

33264 **(UCRL—15788) RESIS: a three-dimensional resistivity and induced polarization computer program based on a surface integral technique. Final report.** Hanson, J.M. (Hanson and Associates, Salt Lake City, UT (USA)). Feb 1986. Contract W-7405-ENG-48. 107p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86010566.

A computer program that calculates apparent resistivity and induced polarization for the situation in which an anomalously conducting body is embedded in a homogeneous half- or whole-space is described. The program can deal with (1) fixed current probes, moving potential probes, (2) fixed potential probes, moving current probes, (3) moving current probes and moving potential probes, and (4) can generate pseudo-depth data. The code allows for two current probes and to potential probes, all of which can be moved independently along any straight line trajectory in 3-space. The half- or whole-space is required to have a uniform (homogeneous and isotropic) electrical conductivity, as does the anomalous body. The anomalous body can be any shape that is not multiply connected. The surface of the anomalous body is approximated by a set of edge-connected triangular facets. The program is written in Microsoft Fortran (Version 3.2). 6 refs., 37 figs., 4 tabs.

33265 **(UFPB-DF—09/85) Interacting collective modes in a laser cavity.** Graca, E.L.; Brito, A.L. de; Baseia, B. (Paraiba Univ., Joao Pessoa (Brazil). Dept. de Fisica). 1985. 10p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701945.

Collective operators are defined for the quantized radiation field in a one-dimensional laser cavity coupled to a semi-infinite outside region and the overlaps of neighbouring collective modes are considered to show how they modify, in the linear appoximation, the time evolution of the radiation field below threshold. The model and procedure work directly within a continuous spectrum of modes and allow us to get an improved insight on the prescription for the laser field in single-mode operation.

33266 **(UFPB-DF—10/85) Equivalence between the methods involving Fourier series and the Poisson's summation formula and evaluation of a class of lattice sums in arbitrary dimensions.** Dias, M.; Chaba, A.N. (Paraiba Univ., Joao Pessoa (Brazil). Dept. de Fisica). 1985. 9p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701919.

The similarities between the Fourier series method and the Poisson's summation formula method are brought out by evaluating the lattice sum g(r) sup(→) identical to Σ sub(tau) sup(→) exp(-lambda [r sup(→) - t sup(→)])/[r sup(→) - tau sup(→)] over a Bravais lattice [tau sup(→)] in three dimensions, lambda and r sup(→) being independent of tau sup(→). It is shown that the two approaches are actually equivalent by proving that the Poisson's summation formula (in any dimensionality) can, itself, be derived from the Fourier series method. An expression is also presented, ready for quick use, for a class of lattice sums Σ sub(tau) sup(→) F([r sup(→) - tau sup(→)]) over a Brafais lattice [r sup(→)] in arbitrary dimensions.

33267 **(UFPB-DF—12/85) On the generation of equivalent Hamiltonians.** Espindola, O.; Teixeira, N.L.; Espindola, M.L. (Paraiba Univ., Joao Pessoa (Brazil). Dept. de Fisica). 1985. 4p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86701920.

A new approach to the equivalence problem (in phase space) is presented. Given a Hamiltonian describing a system of particles with two degrees of freedom (and the corresponding Hamilton-Jacobi equation), it is shown how to find the most general family of Hamiltonian functions that generates new Hamilton-Jacobi equation with the following (and essential) characteristic, here defined as equivalence: every new solution is also a solution of the original Hamilton-Jacobi equation and vice-versa.

33268 **Classical dynamics and Lie groups.** Louck, J.D.; Metropolis, N. (Theoretical Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *American Journal of Physics;* **54**: No. 6, 558-564(Jun 1986).

The phase space time evolution operator for a dynamical system is derived directly from Newton's equation of motion. This operator is used to show, in an elementary way, how a Lie group enters into the description in phase space of the path of a one-dimensional damped, driven, harmonic oscillator. Concepts from Lie group theory are thus illustrated in a nontrivial but elementary and familiar setting. Generalizations of this method for Hamiltonian systems are outlined in a series of remarks that suggest the broader scope of the subject.

33269 **Direct and inverse scattering in the time domain for a dissipative wave equation. II. Simultaneous reconstruction of dissipation and phase velocity profiles.** Kristensson, G.; Krueger, R.J. (Division of Electromagnetic Theory, Royal Institute of Technology, S-100 44 Stockholm, Sweden). *Journal of Mathematical Physics (New York);* **27**: No. 6, 1683-1693(Jun 1986).

The one-dimensional inverse scattering problem for inhomogeneous lossy media is considered. The model problem involves electromagnetic wave propagation in a medium of unknown thickness with spatially varying conductivity and permittivity. Two inversion algorithms are developed in the time domain using data obtained from normally incident plane waves. These algorithms utilize reflection data from both sides of the medium, and one of them also uses transmission data. These algorithms are implemented numerically on several examples, one of which includes the effects of noisy data. The possibility of using one-sided reflection data and no transmission data is reviewed and analyzed.

33270 **Three-cocycle in quantum mechanics. II.** Grossman, B. (The Rockefeller University, 1230 York Avenue, New York, New York 10021). *Physical Review [Section] D: Particles and Fields;* **33**: No. 10, 2922-2929(15 May 1986). Contract AC02-81ER40033.

We offer a new topological interpretation of the three-cocycle in a consistent quantum mechanics. Our basis is homotopy theory. We show how higher cocycles may appear in quantum mechanics. Moreover, a three-cocycle gives rise to a nonassociative al-

gebra describing defects in a quantum-mechanical system. We also show the relation of the three-cocycle to axions in string theory.

33271 **Conditions for nondegeneracy in supersymmetric quantum mechanics.** Imbo, T.D.; Sukhatme, U.P. (Department of Physics, University of Illinois at Chicago, Chicago, Illinois 60680). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 3147-3149(15 May 1986). Contract FG02-84ER40169.

It is shown that the positive "bosonic" and "fermionic" bound-state spectra in spherically symmetric supersymmetric (SUSY) quantum mechanics are degenerate if and only if the superpotential W(r) satisfies δequivalentlim/sub r/→0r'W(r)'> or =0.5. Also, if δ<0.5, then SUSY is broken.

33272 **Gauge invariance and unitarity in higher-derivative quantum gravity.** Antoniadis, I.; Tomboulis, E.T. (Stanford Linear Accelerator Center, Stanford University, Stanford, California 94305). *Physical Review* [*Section*] *D: Particles and Fields;* **33**: No. 10, 2756-2779(15 May 1986). Contract AC03-76SF00515.

The question of unitarity is examined in the renormalizable, "higher-derivative" theory of quantum gravity. It is pointed out that the presence of a massive spin-2 ghost in the bare propagator is inconclusive, since this excitation is unstable. In the presence of unstable particles, expansions using bare propagators are impossible: modified expansions with dressed propagators that exhibit the complex nature of the unstable pole must be employed. It is found, however, that the position of the complex poles in the dressed propagator is explicitly gauge dependent. It turns out that this is a specifically gravitational effect; it does not occur in gauge theories with an internal-symmetry gauge group. On the other hand, a physical S matrix between in and out states containing only transverse, massless gravitons and physical massless matter fields is shown to be gauge independent. It then follows by a standard, albeit formal, argument that the contribution of all gauge-variant poles to its intermediate states must cancel. The physical S matrix should therefore, be unitary. In this development, the standard rules of quantum field theory are followed throughout; no ad hoc modifications, such as the Lee-Wick prescription, are ever invoked.

33273 **Quantum oscillations in one-dimensional metal rings: Average over disorder.** Li, Q.; Soukoulis, C.M. (Ames Laboratory and Department of Physics, Iowa State University, Ames, Iowa 50011). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 10, 7318-7321(15 May 1986). Contract W-7405-ENG-82.

We study the Aharonov-Bohm effect in single normal-metal rings and show that averaging the transmission coefficient T over disorder gives oscillations with a period of a half-flux quantum. As the elastic scattering gets stronger, the periodicity of oscillation of the conductance, which is related to T, gradually changes to a full-flux quantum, in agreement with recent experiments.

33274 **Iterative maps for bistable excitation of two-level systems.** Cho, H.M.; Tycko, R.; Pines, A.; Guckenheimer, J. (Department of Chemistry, Univeristy of California and Materials and Molecular Research Division, Lawrence Berkeley Laboratory, Berkeley, California 94720). *Physical Review Letters;* **56**: No. 18, 1905-1908(5 May 1986). Contract AC03-76SF00098.

Iterative maps on SO(3) with two stable fixed points are described. These generate bistable spectroscopic excitation sequences for isolated two-level systems. From such sequences, tailored population inversion over specific ranges of parameters such as the resonance frequency or radiation amplitude can be obtained. The ideas developed here suggest ways of designing tailored excitation sequences useful in spatially selective NMR, spin decoupling, nk-quantum selective multiple-quantum NMR, and isotope-selective zero-field NMR.

33275 **Truncation errors in the Monte Carlo renormalization group: A comparative study.** Shankar, R. (Physics Department, J. W. Gibbs Laboratory, Yale University, New Haven, Connecticut 06520). *Physical Review* [*Section*] *B: Condensed Matter;* **33**: No. 9, 6515-6518(1 May 1986). Contract AC02-76ER03075.

An explanation is given for the impressive success Swendsen has had in the determination of critical exponents using his method of truncation in the space of operators. A by-product is a way to further improve his numbers and estimate residual truncation errors.

33276 **Improved WKB radial wave functions in several bases.** Durand, B.; Durand, L. (Los Alamos National Laboratory, Los Alamos, New Mexico 87545; Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). *Physical Review* [*Section*] *A: General Physics;* **33**: No. 5, 2887-2898(May 1986). Contract AC02-76ER00881.

We develop approximate WKB-like solutions to the radial Schroedinger equation for problems with an angular momentum barrier using Riccati-Bessel, Coulomb, and harmonic-oscillator functions as basis functions. The solutions treat the angular momentum singularity near the origin more accurately in leading approximation than the standard WKB solutions based on sine waves. The solutions based on Riccati-Bessel and free Coulomb wave functions continue smoothly through the inner turning point and are appropriate for scattering problems. The solutions based on oscillator and bound Coulomb wave functions incorporate both turning points smoothly and are particularly appropriate for bound-state problems; no matching of piecewise solutions using Airy functions is necessary.

33277 **Improved Fermi-Segre formula for absolute value squared of (R/sub n/,1/r/sup 1/)(0) for singular and nonsingular potentials.** Durand, B.; Durand, L. (Department of Physics, University of Wisconsin, Madison, Wisconsin 53706). *Physical Review* [*Section*] *A: General Physics;* **33**: No. 5, 2899-2906(May 1986). Contract AC02-76ER00881.

The Fermi-Segre formula, which relates the value of a normalized S-state radial wave function at the origin to the derivative dE/sub n//dn of the bound-state spectrum in a Schroedinger problem, has been used extensively in problems in atomic and quarkonium physics. The extensions which have been proposed for angular momenta l>0 are quite inaccurate for large l for the confining potentials typical of the quarkonium system. We derive modified formulas for arbitrary l which remove this difficulty.

33278 **Solitons and four-wave mixing.** Ackerhalt, J.R.; Milonni, P.W. (Los Alamos National Laboratory (Box 1663, Mail Stop J569), University of California, Los Alamos, New Mexico 87545). *Physical Review* [*Section*] *A: General Physics;* **33**: No. 5, 3185-3198(May 1986).

We develop the formalism for studying transient four-wave-mixing phenomena in a Raman medium, and apply it to the study of solitary-wave propagation. We consider the problems of second-Stokes generation, anti-Stokes scattering, and two-pump Raman scattering.

33279 **Stability of solutions to Sturm-Liouville diffusion equations.** van der Mee, C.V.M. (Department of Mathematics and Computer Science, Clarkson University, Potsdam, New York 13676). *Transport Theory and Statistical Physics;* **15**: No. 3, 297-316(May 1986). Contract AS05-80ER10711.

Stability of solutions of abstract half-space problems of the type Tpsi'(x) = -Apsi(x)(0<x<∞) is established under perturbations of the resolvent of the (unbounded) positive self-adjoint operator A. Applications are given to Sturn-Liouville type diffusion equations.

33280 **Inequality for the infinite-cluster density in Bernoulli percolation.** Chayes, J.T.; Chayes, L. (Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14853). *Physical Review Letters;* **56**: No. 16, 1619-1622(21 Apr 1986). Contract AC02-83ER13044.

Under a certain assumption (which is satisfied whenever there is a dense infinite cluster in the half-space), we prove a differential inequality for the infinite-cluster density, P/sub infinity/(p), in Bernoulli percolation. The principal implication of this result is that if P/sub infinity/(p) vanishes with critical exponent β, then β obeys the mean-field bound $\beta <$ or $= 1$. As a corollary, we also derive an inequality relating the backbone density, the truncated susceptibility, and the infinite-cluster density.

33281 **Deterministic Ising dynamics.** Creutz, M. (Department of Physics, Brookhaven National Laboratory, Upton, New York 11973). *Annals of Physics (New York);* **167**: No. 1, 62-72(Mar 1986). Contract AC02-76CH00016.

A deterministic cellular automation rule is presented which simulates the Ising model. On each cell in addition to an Ising spin is a space-time parity bit and a variable playing the role of a momentum conjugate to the spin. The procedure permits study of non-equilibrium phenomena, heat flow, mixing, and time correlations. The algorithm can make full use of multispin coding, thus permitting fast programs involving parallel processing on serial machines.

33282 **Tests for Monte Carlo renormalization studies on Ising models.** Murthy, G.; Shankar, R. (J. W. Gibbs Laboratory of Physics, Yale University, New Haven, Connecticut 06520). *Journal of Statistical Physics;* **42**: No. 2, 275-492(Feb 1986). Contract AC02-76ER03075.

In this expanded version of an earlier letter, we consider many computational details that were omitted for want of space. For d = 2 Ising spins with up to 13 different short-range interactions, we construct the critical surface in the vicinity of (Onsager's) nearest-neighbor (nn) critical point by using the body of the available information on the solvable nn case. We then see if the Monte Carlo renormalization group flows generated from this point do indeed lie on this surface and quantify the errors if they do not.

6580 Mathematical Physics

REFER ALSO TO CITATION(S) 32975, 33208, 33210, 33211, 33224, 33248, 33249, 33250, 33264, 33275, 33279, 33290, 33338, 33339, 33475, 33476, 33487

33283 **(CONF-8604168—1) Deterministic sensitivity theory for nonlinear systems: the forward and the adjoint method.** Cacuci, D.G. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 80p. NTIS, PC A05/MF A01; GPO Dep. File Number DE86009512.

From ISPRA course on data uncertainties, sensitivities, consistency, and adjustment; Ispra, Italy (14 Apr 1986).

The main aspects underlying the rigorous mathematical formulation of deterministic sensitivity theory for nonlinear systems are presented; this formulation is based on the work by Cacuci and employs concepts and methods of nonlinear functional analysis. The functional analytic concepts underlying sensitivity theory are briefly reviewed in Section II. The rigorous formulation of sensitivity theory for nonlinear systems is presented in Section III. Section III.A presents the sensitivity theory for nonlinear systems with operator-type responses. Section III.B presents the development of the sensitivity theory for nonlinear systems with responses defined at critical points of a function of the system's state vector and parameters (maxima, minima, and saddle points). Section III.C presents sensitivity theory for nonlinear systems with feedback. Finally, Section IV summarizes and highlights the main points underlying deterministic sensitivity theory for nonlinear systems and discusses the potential of using functional analytic concepts to extend further the scope of this theory. 37 refs. (DWL)

33284 **(ORNL/TM—9931) Critical radius for nucleation.** Alexiades, V.; Solomon, A.D. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 21p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010072.

The free energy of formation and the critical radius for homogeneous nucleation of a spherical nucleus in supercooled liquid, at given temperature and ambient pressure, are determined, taking fully into account surface area, curvature, and pressure effects. The specific heats and densities of the two phases are allowed to be different and all thermophysical properties are temperature dependent. In the simple case in which classical nucleation theory is valid, the results predict a critical radius of about 40% larger than the classical value, and an activation energy barrier of almost three times larger than the classical value. 8 refs.

33285 **(ORNL/TM—10016) Propagators for general nonlinear equations.** Cacuci, D.G.; Perez, R.B.; Protopopescu, V. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010071.

Propagators - advanced and retarded - are introduced for nonlinear problems and it is shown that they generalize the Green's functions used to solve linear problems. These propagators are generated by using the dual operator which plays, for the nonlinear problem, the same role as the customary adjoint operator for linear problems. The propagators obey a reciprocity relationship and satisfy a closed nonlinear integral equation or, alternatively, a linear integral equation that depends parametrically on the problem's solution. These equations are formulated in a canonical way, independent of dimensionally, boundary conditions and type of the underlying nonlinear problem. 8 refs.

33286 **(SAND—86-0040C) S_2-synthetic acceleration scheme for the one-dimensional S/sub n/ equations.** Lorence, L.J. Jr.; Larsen, E.W.; Morel, J.E. (Sandia National Labs., Albuquerque, NM (USA); Los Alamos National Lab., NM (USA)). 1986. Contract AC04-76DP00789. 7p. (CONF-860610—8). NTIS, PC A02/MF A01; GPO Dep. File Number DE86005628.

From American Nuclear Society annual meeting; Reno, NV, USA (15 Jun 1986).

An S_2-synthetic acceleration method for the one-dimensional S/sub n/ equations is developed with linear-discontinuous spatial differencing and is implemented in a new version of the ONETRAN code. The zero'th and first moments of the scattering source are accelerated. This is done by solving the S_2 equations with the Gauss quadrature rather than the diffusion equation as the low-order operator in the synthetic acceleration scheme. 5 refs., 2 tabs.

33287 **(SAND—86-0716) Some experiments with numerical pivoting in a code for solving large sparse stiff systems of odes.** Salane, D.E. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010305.

The effect of pivoting in a code is examined for the solution of large sparse stiff systems of odes. Experiments with a recent code (DEBDFS) are presented. These experiments indicate that some pivoting for numerical stability is essential in these codes. 21 refs., 3 tabs.

33288 **(UCRL—53683) Eulerian transport in general orthogonal curvilinear coordinates.** Sinz, K. (Lawrence Livermore National Lab., CA (USA)). Oct 1985. Contract W-7405-ENG-48. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010266.

Eulerian fluid transport in general orthogonal curvilinear coordinates is calculated in the KEYSTONE code. Prescriptions are given for the volume and area calculations that allow for the curvature of the zones, as well as the complications introduced by extreme aspect ratios of the zone sizes. Singularities in the mesh are considered, and metrics are obtained from a numerically specified mesh. Many of the demonstrated techniques are independent of the coordinate system and could be used in standard Lagrangian codes. 4 refs., 2 figs.

33289 **Mathematical models of hysteresis.** Mayergoyz, I.D. (Electrical Engineering Department, University of Maryland, College Park, Maryland 20742). *Physical Review Letters;* **56**: No. 15, 1518-1521(14 Apr 1986). Contract AS05-84ER13145.

A new approach to Preisach's hysteresis model, which emphasizes its phenomenological nature and mathematical generality, is briefly described. Then the theorem which gives the necessary

and sufficient conditions for the representation of actual hysteresis nonlinearities by Preisach's model is proven. The significance of this theorem is that it establishes the limits of applicability of this model.

70 FUSION ENERGY

7001 Plasma Research

REFER ALSO TO CITATION(S) 32916, 32944, 32945, 32967, 33442, 33444, 33445, 33445

33290 (CEA-N—2441) Particle methods for Boltzmann equation. Hermeline, F. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). May 1985. 44p. (In French). NTIS (US Sales Only), PC A03/MF A01. File Number DE86751825.

This work is aimed at showing how to discretize an equation such as Boltzmann equation in its most general form, by particle methods. Then method is applied to some equations of plasma physics which appear as peculiar cases of Boltzmann equation, such as Vlasov equation, Bhatnager-Gross-Krook equation, Fokker-Planck equation and neutron transport equation.

33291 (CONF-860522—1) Measurement of the hydrogen recombination coefficient in the TEXT tokamak as a function of outgassing and power radiated during tokamak discharges. Langley, R.A.; Rowan, W.L.; Bravinec, R.V.; Nelin, K. (Oak Ridge National Lab., TN (USA); Texas Univ., Austin (USA). Fusion Research Center). 1986. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010400.

From 7. international conference on plasma surface interactions in controlled fusion devices; Princeton, NJ, USA (5 May 1986).

The global recombination rate coefficient k/sub r/ for hydrogen has been measured in the TEXT tokamak vacuum for various surface conditions. An attempt was made to correlate the measured values of k/sub r/ with RGA data taken prior to each k/sub r/ measurement and with the power radiated during tokamak discharges produced after each k/sub r/ measurement. The results show that: k/sub r/ increases during a series of tokamak discharges, k/sub r/ is relatively insensitive to power radiated during tokamak discharges, k/sub r/ increases with the RGA measurements of mass 28 and 40 but not with mass 18. In addition, it was found that the RGA mass 18 (H_2O) signal decreased as glow discharge experiments with hydrogen were performed.

33292 (DOE/ER/53208—1) Excitation and ionization of highly charged ions by electron impact. Progress report, September 1, 1985-April 30, 1986. Sampson, D.H. (Pennsylvania State Univ., University Park (USA)). 30 Apr 1986. Contract FG02-85ER53208. 18p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010580.

Calculations of atomic data for applications to fusion energy research are outlined, and a summary of all the results obtained for both ionization and excitation are given. The most recent results obtained within the past eight months since the present grant took effect are the following: (1) the determination of the branching ratios or relative probabilities for the final state of the core or next stage of ionization when a complex ion is excited to a very high bound level or the continuum (ionization). These branching ratios apply for either collisional or radiative transitions; (2) the determination of the resonance contribution to excitation rates for all 21 transitions involving the ground level and/or the singly excited n = 2 levels in 18 He-like ions; (3) the collision strengths and oscillator strengths for all the 88 fine structure transitions from the ground level to the singly excited levels with n = 3 and 4 in 18 Neon-like ions. Recent work on a new quasirelativistic approach is also briefly discussed. 51 refs.

33293 (DOE/ET/53088—1) Institute for fusion studies. Progress report, September 1, 1984-August 31, 1985. (Texas Univ., Austin (USA). Inst. for Fusion Studies). Aug 1985. Contract FG05-80ET53088. 74p. NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86010289.

Drift and tearing modes in a sheared cylindrical collisionless plasma column are studied. A set of differential equations in the radial coordinate are derived with small gyroradius and low-β expansion. The finite-β effects include curvature drifts, gradient-B drifts, and the parallel magnetic field perturbation. Algebraic elimination reduces the resulting set of equations to a fourth-order system. Analysis shows that bad curvature does not drive the collisionless modes unstable.

33294 (ENEA-RT/FIMA—82-8) Preliminary Monte Carlo model of neutral transport in plasma. Cupini, E.; De Matteis, A.; Simonini, R. (ENEA, Bologna (Italy). Dipartimento Tecnologie Intersettoriali di Base). Sep 1982. 23p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86901373.

A Monte Carlo program, MNP, has been written, which solves the steady-state transport equation of neutral particles in a plasma, for a fixed-source problem in a two-dimensional very general configuration. Fluxes, densities, reaction rates, wall heating and escape probabilities are the main quantities computed by the program. Two interactions of neutrals with the plasma ions and electrons have been considered: electron ionization and charge-exchange. Wall interactions considered are backscattering and reemission in atomic state. A summary description of the code is given, together with some preliminary results obtained in the study of a poloidal divertor for helium ash enrichment and exhaust. Section 2 contains a description of the interactions of neutrals with plasma; Section 3 describes the models used for interactions of neutrals with walls; in Section 4 the main features of birth from source, history tracking and estimators are given.

33295 (EUR-CEA-FC—1273) Charged fusion products in a Tokamak. Martin, G. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Recherches sur la Fusion Controlee; Paris-11 Univ., 91 - Orsay (France)). May 1985. 213p. (In French). NTIS (US Sales Only), PC A10/MF A01. File Number DE86751592.

In fusion reactions, charged particles are generated; they are more or less confined in the magnetic fields. Results reachable by charged fusion products analysis justify the work, especially on the large experiments like Tore-Supra or J.E.T., where the power produced may reach a few MW. They can be used as diagnostic for the plasma, and as experimental prediction of the confinement of alpha particles, which is necessary for the reactor. Practical use of a semi-conductor detector on a Tokamak is technically difficult: the problems have been studied on T.F.R. Encouraging results have been obtained, with 3 MeV (D-D) and 15 MeV (D-He^3) proton spectra. Calculations on particle trajectories, damping and scattering in Tore Supra are also presented.

33296 (EUR-CEA-FC—1278) Thermal stability of a thermonuclear plasma for different confinement scaling laws. Johner, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Recherches sur la Fusion Controlee). Oct 1985. 27p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751802.

The thermal stability of the ignition curve is investigated using a simple OD model for a temperature dependent energy confinement time (tausub(E) is proportional to 1/Tsup(γ)). The stability limit in the (ntausub(E),T) plane is also calculated for a plasma with external heating. The degradation of confinement time with increasing temperature is found to be favourable for divergence temperature and minimum temperature for stable ignition. It also decreases the external power per unit volume necessary to reach divergence. On the contrary, it is extremely unfavourable for the required μsub(E) for divergence and ignition. Detailed results are given for the special case of the Kaye-Goldston scaling (γ=1.38).

33297 (EUR-CEA-FC—1279) Gas heating effects in the neutralisers of neutral beam injection lines. Pamela, J. (Association Euratom-CEA, Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Recherches sur la Fusion Controlee). Oct 1985. 27p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86751801.

Measurements of the linear gas density in the neutraliser of the FAR neutral deuterium beam injection test line have been made, using the charged products of D(d,p)T fusion reactions. They show a disagreement with the linear density expected from conductance measurements made in the absence of beam. Non-molecular flow cannot explain this effect, but a model of gas heating seems to be able to account for it. For the JET neutral beam line, this means an efficiency loss of about 20%. Due to the narrow transverse dimension of its neutraliser, the effect on the future Tore-Supra neutral beam injection line should not be as dramatic.

33298 (FRNC-TH—2118) Reiterated inclusions of dipoles in a dense plasma. Naouri, G. (Paris-11 Univ., 91 - Orsay (France)). Jun 1983. 149p. (In French). NTIS (US Sales Only), PC A07/MF A01. File Number DE86751788.

This thesis introduces a simple model made up for the calculation of pressure effects in dense and partially ionized 3 D two component plasma. The technic used is the description of the overlapping of atomic orbitals by means of interacting dipoles incased in one another. By iteration of this procedure we get an effective two-body potential which allows us to calculate line shifts of hydrogenic ions. In conclusion we suggest a possible improvement of the method by substituting a self consistent potential to the Debye one for the calculation of the wave functions.

33299 (FRNC-TH—2123) Theoretical study of atomic structure of Z<40 elements, ionic excited state populations in a hot plasma and population inversions. Guennou, H. (Paris-11 Univ., 91 - Orsay (France)). May 1983. 197p. (In French). NTIS (US Sales Only), PC A09/MF A01. File Number DE86751793.

This thesis presents a theoretical method for atomic-structure calculations (energy levels, wave functions, oscillator strengths): it is a modified Hartree-Fock method including the spin-orbit interaction in the variationnal process. Two applications are first described: one concerning the resonance lines of the Krypton isoelectronic sequence, the other having for purpose the interpretation of Lsub(α) and Lsub(β) satellites in Copper. A description is made of an original collisional-radiative model, which makes use of the preceding method, and allows to calculate the populations of a great number of ionic excited levels in a plasma. This model is used in a detailed study of the Al^{10+} Lithium -like ion spectrum. It is able to explain the apparition of inversion populations for some special electronic densities and temperatures, for example between the levels corresponding to the transitions observed at 103.8, 105.7 and 154.7 A.

33300 (FRNC-TH—2124) Resonant absorption in a exponential electronic density gradient. Colunga, M. (Paris-11 Univ., 91 - Orsay (France)). Jun 1983. 120p. (In French). NTIS (US Sales Only), PC A06/MF A01. File Number DE86751790.

We use the capacitor model to study resonant absorption in a hot, unmagnetised, Maxwellian, inhomogeneous plasma. We integrate the linearised Vlasov equation to get a non local dispersion relation for the Fourier transform of the electric field. We solve this dispersion relation in two domains of the wave number, klambdasub(D). For weak gradients of the electron density, we correct the hydrodynamic equations by adding a Landau damping term. For steep gradients, we solve the dispersion relation numerically.

33301 (FRNC-TH—2126) Contribution to the study of the interaction of intense relativistic electron beam with anodic plasma. Peugnet, C. (Paris-11 Univ., 91 - Orsay (France)). 1983. 180p. (In French). NTIS (US Sales Only), PC A09/MF A01. File Number DE86751789.

The interaction relativistic electron beam-thin target study is aimed at finding conditions to high energy deposition. A classical interaction gives only a weak energy deposition, this one can only grow with electron trajectory lengthening in the target. Electric and magnetic fields can be used in this way. The experiment shows that the interaction is greatest at the end of the impulsion where a current augmentation and voltage drop occur. During a part of the impulsion, current is classically transmitted. Then it drops during electron target interaction. Electron space charge has been tried to be compensated by plasma ion source, created by laser energy deposition.

33302 (FRNC-TH—2159) Study on the hydrogen negative ion in low pressure discharges. Bruneteau, A.M. (Paris-11 Univ., 91 - Orsay (France)). Jul 1983. 392p. (In French). NTIS (US Sales Only), PC A17/MF A01. File Number DE86751794.

A new use of negative hydrogen ions is the production of intense fast neutral atom beams useful in plasma heating in thermonuclear heating. That is one of the reasons that started this study. The density of negative hydrogen ions in diffusion, and multipole-type low pressure (10^{-3} - 10^{-2} Torr) discharges is deduced from the various formation and destruction processes of the species present in these discharges. The H^- ions are essentially produced by dissociative attachment to vibrationally excited molecules and destroyed by processes the relative importance of which is discussed as a function of the discharge parameters. The experimental study of the density of the H^- ions, measured by photodetachment, as a function of these parameters, coroborates the theoretical model.

33303 (IAE—3866/7) Study on the tokamak scrape-off layer region. Bugarya, V.I.; Grashin, S.A.; Chankin, A.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1983. 36p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86701946.

Using Langmuir probes at the T-10 and TM-4 tokamaks the effect of the plasma interaction with the tokamak wall and limiter on the scrape-off layer plasma parameter distribution over poloidal angle and along magnetic field force lines is investigated. The behaviour of the scrape-off layer plasma parameters, concentration and electron temperature, luminescence of hydrogen atom line Hsub(β) and impurity lines in the immediate proximity to the limiter and at different distances from it are studied. For this purpose in the TM-4 tokamak experiments a mobile limiter capable of moving along the torus large by-pass has been used. It is shown that the neutrals injection into the tokamak plasma occur mainly on the ion toroidal drift side, the chamber wall sputtering proceeds more intensively near the limiter. Electron temperature and concentrations in the tokamak scrape-off layer depend but slightly on the degree of the limiter movement into the plasma. In the TM-4 tokamak limiter region an Hsub(β) line enhanced luminescence is observed. The limiter luminescence drops almost exponentially with the drop length of 4 cm. The intensity of the luminescence line of sputtered material atoms of the TM-4 tokamak MoI limiter drops with an increase in the distance from the limiter, the characteristic drop length being 0.7 cm which corresponds to the 1-5 MeV atom energy. Using the TM-4 tokamak the effect is revealed of plasma concentration increase by 10-40%, as the distance from the limiter along the force lines of the magnetic field increases.

33304 (IAE—3907/6) Simulation of space dependences of charged particle distribution functions in an open adiabatic trap. Golovin, I.N.; Ershov, A.A.; Filimonenko, A.I.; Khvesyuk, V.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 24p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701944.

Study on space dependences of electron and ion distribution functions, electric potential and other plasma parameters is the actual task in connection with the development of physical representations of processes in open traps, their structure modification and production of open complex multimirror systems. Distribution functions of electron and ion velocity have been found within the framework of two dimensional systems with respect to rates space and one-dimensional systems in physical space task as well as dependence of electric potential distribution on a space coordinate in an open adiabatic trap. Numerical algorithm for calculating space

dependences of plasma parameters in a magnetic trap has been developed. A set of the task, basic equations and results of numerical similation are stated. It is shown that the profile of an external magnetic field plays a determining role in the distribution of ambipolar plotential. Magnetic fields have affects mainly on ions, and electric fields on electrons.

33305 **(IAE—3947/14) Optical system for nitrogen laser probing near electrode plasma in the Angara-1 accelerator diode.** Bajgarin, K.A.; Gubanov, E.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 12p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701947.

A pulse nitrogen laser, which may be used under a multimode operation conditions for diagnostics of plasma in different optical systems, is designed and manufactured. Application of the modified Schlieren method allows one to accomplish probing of dense near-to-electrode plasma in a diode of the "Angara-1" heavy-current accelerator. The results obtained indicate to the effect of the beam intrinsic magnetic field on the dynamics of anode plasma scattering.

33306 **(IAE—3961/8) On the stabilization of overheating instability of a thermonuclear reactor-tokamak.** Krasheninnikov, S.I.; Mel'dianov, A.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 8p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701950.

The fact that the stationary state of the thermonuclear deuterium-tritium reaction in the reactor-tokamak can be temperature instable is studied. The physical nature of the given instability is associated with different dependences of energetic lifetime and power of thermonuclear energy release on plasma temperature. It is revealed that realization of the steady-state self-sustaining D-T-reaction is possible at controlled pellets fueling of the central part of the plasma filament. A physical mechanism ensuring thermonuclear reaction is associated with overheating of the central part of the filament and increase of the threshold value p, while going into the stationary mode is conditioned by rather small effective lifetime of the plasma in the central region. The problem of stabilizing overheating instability of the reactor-tokamak is considered. If we assume that the power of thermonuclear energy release Q is Q approximately Tsup(p) then the parameter of exponent p drops with growth of plasma temperature and at T >= 30 keV it turns to be less than one. In this case overheating instability does not take place.

33307 **(IAE—3979/6) Calculation of the electron distribution function and plasma X-ray spectra in an external electric field.** Dnestrovskij, Yu.N.; Zajtsev, F.S.; Kostomarov, D.P.; Luk'yanitsa, A.A.; Smirnov, A.P. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 13p. (In Russian). NTIS (US Sales Only), PC A02/MF A01. File Number DE86701943.

Electron distribution function of plasma, being in a weak electric field, is derived on the basis of the numerical solution of the two-dimensional linearized kinetic equation. X-ray spectra are calculated for a wide range of a change of the external electric field at different values of plasma effective charge. The results may be used for experimental spectra processing.

33308 **(IAE—4042/7) Study on the plasma dynamics in a high-current diode. (Shadow methods).** Gorbulin, Yu.M.; Zlotnikov, D.M.; Znamenskaya, I.A.; Kalinin, Yu.G.; Skoryupin, V.A.; Shashkov, A.Yu. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 27p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86701948.

Dynamics of diode plasma scattering of the "Mirasch" REB high-current accelerator is studied by the Schlieren method. The accelerator has the voltage of 800 kV, current of 200 kA at pulse duration of 60 ns under beam focusing refime. Diagnostics comprises laser probing of a diode within a wide wavelength range (0.266 μm <lambda <= 5.23 μm) with the use of different optical schemes. Deceleration of anode plasma in a dode gap is discovered, kinematic and dynamic characteristics of plasma motion are studied, and anode plasma temperature is determined. Experimental results are compared with calculations for the case of a flat plasma layer.

33309 **(INIS-BR—464) Effect of the poloidal current from the classical diffusion in the steady-state neo-classical transport.** Igna Junior, A.D. (Instituto Militar de Engenharia, Rio de Janeiro (Brazil)). 1984. 166p. (In Portuguese). NTIS (US Sales Only), PC A08/MF A01. File Number DE8o701951.

The relevant parameters of two steady-state models of a plasma column, in fusion regime, were analyzed fo- an ideal Tokamak. The neo-classical transport theory was considered in the banana regime and in the Pfirsch-Schlueter regime. The first model proposes a correction in the numerical coefficients of the transport equations. In the other one, a poloidal current from Pfirsch-Schlueter classical diffusion is considered aiming to satisfy the pressure balance.

33310 **(JET-R—84-01) MESHJET. A mesh generation package for finite element MHD equilibrium codes at JET.** Springmann, E.; Taroni, A. (Commission of the European Communities, Abingdon (UK). JET Joint Undertaking). 1984. 35p. NTIS (US Sales Only), PC A03/MF A01. File Number DE86701949.

MESHJET is a fairly general package and can be used to generate meshes for any finite element code in two space dimensions. These finite element codes are widely used at JET. The first code is for the identification of the plasma boundary and internal flux surfaces from measurements of external fluxes and fields under the assumption that the plasma toroidal density can be represented within a given class of functions. The second code computes plasma equilibrium configurations taking into account a two-dimensional model of the transformer iron core in JET.

33311 (LBL—19100, pp 34-36) **Atomic physics and theoretical studies.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

Concurrent with the design and testing of neutral-beam systems, work continued in 1984 on developing appropriate beam diagnostic techniques. As an outgrowth of these efforts, a technique was proposed for producing intense beams of electron- and nuclear-spin-polarized atoms. This technique, which we call collisional pumping, could be used not only to heat and fuel a fusion plasma, but also to make possible new kinds of nuclear physics experiments. Theoretical work also continued, the aim being a better understanding of the processes and interactions that occur in plasmas.

33312 **(UCID—19776) Evaluation of ion-energy spectrometers for use on MFTF.** Falabella, S.; Grubb, D.P. (Lawrence Livermore National Lab., CA (USA)). 12 Apr 1983. Contract W-7405-ENG-48. 29p. NTIS, PC A03/MF A01; GPO Dep. File Number DE86010641.

This report was originally written as part of the Physics Analysis Document for the End-Loss Ion Energy Spectrometer for MFTF. In the course of that analysis, we investigated many possibilities. We have decided that this survey of the different types of analyzers and detectors could be of use to others facing a similar choice. The Appendix covers a formalism developed for finding the trajectories of charged particles in constant, uniform, but otherwise arbitrary electric and magnetic fields.

33313 **(UCRL—94360) Plasma processes in non-ideal plasmas.** More, R.M. (Lawrence Livermore National Lab., CA (USA)). Mar 1986. Contract W-7405-ENG-48. 60p. (CONF-8507117—1). NTIS, PC A04/MF A01; 1; GPO Dep. File Number DE86009399.

From 29. Scottish Universities summer school in physics: laser plasma interactions; St. Andrews, Scotland (28 Jul 1985).

Non-ideal plasma equation of state, radiative cross-sections and energy exchange coefficients are described in a tutorial overview.

33314 Modification of lower-hybrid current ramp-up by runaways. Chan, V.S.; Liu, C.S.; Lee, Y.C. (GA Technologies Inc., San Diego, California 92138). *Physics of Fluids;* **29**: No. 6, 1900-1907(Jun 1986). Contract AC03-84ER53158.

Runaway effects on lower-hybrid current ramp-up are studied numerically using a two-dimensional Fokker—Planck analysis and a nonlinear circuit equation. Runaway contribution to the inductance is shown to be important in limiting the magnitude of the induced electric field. This tends to reduce the current ramp-up efficiency. However, for a range of ω/sub p//Ω, the anomalous Doppler instability can be excited and the runaway production rate as well as the associated inductance is significantly reduced when that happens. This allows the ramp-up efficiency to be further increased.

33315 Helical axis stellarator equilibrium and resistive ballooning. Depassier, M.C.; Cooper, W.A. (Facultad de Fisica, Universidad Catolica de Chile, Casilla 114-D, Santiago, Chile). *Physics of Fluids;* **29**: No. 6, 1948-1958(Jun 1986).

An approximate analytic solution of the magnetohydrodynamic (MHD) equilibrium equation for large-aspect-ratio, helically symmetric systems is obtained. The resistive ballooning stability of these equilibria is studied numerically and analytically. We find that the ballooning modes scale as the resistivity to the third power. They are driven by the helical nature of the magnetic axis and by the elliptic distortion of the flux surfaces away from a circle.

33316 Radio frequency breakdown and electron confinement time in a stellarator. Wroblewski, D.; Shohet, J.L. (The University of Wisconsin, Torsatron/Stellarator Laboratory, Madison, Wisconsin 53706). *Physics of Fluids;* **29**: No. 6, 1979-1984(Jun 1986). Contract AC02-84ER53166.

Radio frequency (f = 350 kHz) inductive breakdown has been studied in a toroidal stellarator. The time delay between the application of the radio frequency pulse and the buildup of detectable plasma density is measured as a function of the discharge parameters. It is shown that the confinement time of energetic electrons (~100 eV), produced during the breakdown, may be deduced from the breakdown characteristics. The experimentally determined confinement times are compared with predictions of neoclassical transport theory and are found to have functional dependence on the discharge parameters approximately consistent with plateau scaling, but to be shorter than predicted by the neoclassical diffusion model.

33317 Renormalized turbulence theory of ion pressure gradient driven drift modes. Hong, B.; Choi, D.; Horton W. Jr. (Department of Physics, Korea Advanced Institute of Science and Technology, P.O. Box 150 Cheongryangni, Seoul, Korea). *Physics of Fluids;* **29**: No. 6, 1872-1880(Jun 1986). Contract FG05-80ET53088.

From the nonlinear gyrokinetic equation we formulate the renormalized turbulence equation for the eta/sub i/ -mode drift wave instability. The study shows that the dominant nonlinear damping mechanism is from the E x B convection of the pressure fluctuation and that the kinetic modifications to the fluid E x B mode coupling, studied earlier, shift the spectrum toward the shorter wavelengths. Balancing the linear growth rate with the nonlinear damping rate at the linearly most unstable region, we calculate the anomalous ion thermal conductivity, which exceeds the neoclassical plateau formula and gives a value of the same order as that previously computed by Horton, Choi, and Tang [Phys. Fluids 26, 1077 (1981)], but with a kinetic enhancement factor. Also, the thermal conductivity formula remains finite for vanishing density gradient.

33318 Reply to comments of Catto and Myra. Shaing, K.C. (Oak Ridge National Laboratory, P. O. Box Y, Oak Ridge, Tennessee 37831). *Physics of Fluids;* **29**: No. 6, 2021-2021(Jun 1986). Contract AC05-84OR21400.

If tau/sub a/ << tau/sub D/, where tau/sub a/(tau/sub D/) is the relaxation time for the radial electric field (plasma density and temperature), a unique, stable value of the radial electric field is determined on the time scale tau/sub a/ << tau << tau/sub D/.

33319 Influence of resistivity on energetic trapped particle-induced internal kink modes. Biglari, H.; Chen, L. (Department of Astrophysical Sciences and Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Physics of Fluids;* **29**: No. 6, 1760-1764(Jun 1986). Contract AC02-76CH03073.

The influence of resistivity on energetic trapped particle-induced internal kink modes, dubbed "fishbones" in the literature, is explored. A general dispersion relation, which recovers the ideal theory in its appropriate limit, is derived and analyzed. An important implication of the theory for present generation fusion devices such as the Joint European Torus [Plasma Physics and Controlled Nuclear Fusion Research (IAEA, London, 1984), Vol I, p.11] is that they will be stable to fishbone activity.

33320 Growth of phase space holes near linear instability. Dupree, T.H. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physics of Fluids;* **29**: No. 6, 1813-1819(Jun 1986).

Previous calculations of hole growth in a one-dimensional electron—ion plasma are extended to a greater range of parameter space including the region around linear instability. The effect of the ion-acoustic resonance on hole growth is analyzed and the relationship to linear instability is discussed. Agreement with computer simulations is much improved. Energy and momentum conservation are discussed and proved for both holes and waves.

33321 Semicollisional drift-tearing modes in toroidal plasmas. Hahm, T.S.; Chen, L. (Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712-1068). *Physics of Fluids;* **29**: No. 6, 1891-1899(Jun 1986). Contract AC02-76CH03073.

Semicollisional drift-tearing modes are studied analytically in toroidal plasmas. Corresponding differential equations for the eigenmodes are derived via the ballooning mode representation and flux-surface averaging. A dispersion relation is then obtained using asymptotic matching. It is found that the stabilizing effects of good average curvature and finite plasma compression lead to a tearing instability threshold Δ/sub c/, which is independent of the resistivity.

33322 Oscillation center theory and ponderomotive stabilization of low-frequency plasma modes. Similon, P.L.; Kaufman, A.N.; Holm, D.D. (Lawrence Berkeley Laboratory and Physics Department, University of California, Berkeley, California 94720). *Physics of Fluids;* **29**: No. 6, 1908-1922(Jun 1986).

Nonlinear, nondissipative ponderomotive theory is developed in relation to recent experimental results showing that externally imposed rf fields can stabilize an axisymmetric mirror plasma. First, the ponderomotive force problem is reexamined, with emphasis on self-consistency of the interaction between the plasma and high-frequency field. The averaged action principle for the antenna—plasma system yields self-consistent plasma and electromagnetic field dynamics on the oscillation-center time scale. The plasma equilibrium condition is expressed as a balance among plasma and magnetic pressure forces, including interchange, ponderomotive, and magnetization forces. Next, the spectral stability of such static equilibria is studied in the low-frequency magnetohydrodynamic (MHD) approximation, with a ΔW principle that incorporates the various ponderomotive contributions: particle effects, magnetization effects, and self-consistent adjustment of the rf field resulting from displacements of the plasma away from equilibrium. The ponderomotive potential energy functional is related to the antenna inductance and antenna current amplitude. Finally, the noncanonical Hamiltonian formulation for the system's dynamics is given, in terms of Eulerian fields. It allows the construction of nonlinearly conserved functionals, which yield criteria for linearized Lyapunov stability, for both multifluid and MHD models. The Lyapunov stability conditions are related to the modified ΔW variational principle.

33323 **Stability of compact-torus ion-ring hybrid systems to magnetohydrodynamic tilt and shift modes.** Turnbull, A.D.; Sudan, R.N. (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853). *Physics of Fluids;* **29**: No. 6, 1923-1938(Jun 1986). Contract AC02-76ET53065.

The low-frequency stability of a compact-torus ion-ring hybrid configuration, in which part of the toroidal current is carried by a ring of high-energy ions, is studied. In particular, the magnetohydrodynamic (MHD) tilt and radial shift instabilities in spheromak-like hybrid systems are considered. The ion ring has a stabilizing effect on the tilt mode, through its modification of the magnetic geometry. For the shift mode, the stabilization is dynamic for moderate elongation, but is again geometrical in the limit of large elongation. For moderate elongation, it is found that a high-energy ion component substantially enhances stability against the MHD shift mode.

33324 **Nonlinear saturation of the absolute stimulated Raman scattering instability in a finite collisional plasma.** McKinstrie, C.J.; Simon, A. (Laboratory for Laser Energetics and Department of Mechanical Engineering, University of Rochester, 250 East River Road, Rochester, New York 14623-1299). *Physics of Fluids;* **29**: No. 6, 1959-1970(Jun 1986). Contract FC08-85DP40200.

Using multiple time scale analysis, the nonlinear saturation of the absolute stimulated Raman scattering instability is examined in a finite homogeneous collisional plasma. The amplitude of the incident wave is assumed to exceed the absolute instability threshold by the fractional amount $\Delta(<<1)$. A single backscattered wave and a single plasma wave grow until time-asymptotic saturation occurs. The reflected light intensity is determined analytically and is proportional to Δ. The spatial variation of the saturated wave amplitudes is also obtained. The reflected intensity is compared to the values predicted for the convective instability, for incident intensities which are marginally less than the absolute threshold intensity. In "short" plasmas, i.e., ones which extend over only a few linear convective gain lengths, the reflected light intensity is found to be much higher when the absolute instability is excited.

33325 **Particle confinement and the anomalous Doppler instability during combined inductive and lower-hybrid current drive.** Luckhardt, S.C.; Chen, K.; Mayberry, M.J.; Porkolab, M.; Terumichi, Y.; Bekefi, G.; McDermott, F.S.; Rohatgi, R. (Plasma Fusion Center and Research Laboratory of Electronics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physics of Fluids;* **29**: No. 6, 1985-1993(Jun 1986). Contract AC02-78ET51013.

Increases in average density have been observed during lower-hybrid current-drive experiments (LHCD) on the Versator II tokamak [Phys. Rev. Lett. 48, 152 (1982)], and on other LHCD experiments where inductive-Ohmic and lower-hybrid current drive are combined. In the present experiment it is found that this density increase is the result of an improvement in global particle confinement time tau/sub p/ in comparison to purely Ohmic discharges with similar plasma parameters. Furthermore, it is found that the improved confinement deteriorates when the anomalous Doppler relaxation instability of the anisotropic high-energy electron tail becomes unstable during LHCD, and the loss rate of tail electrons increases. However, energetic electron losses alone are at least an order of magnitude too small to explain this deterioration in particle confinement.

33326 **Large amplitude ion holes.** Dupree, T.H. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *Physics of Fluids;* **29**: No. 6, 1820-1827(Jun 1986).

Earlier work [Phys. Fluids 25, 277 (1982); Phys. Fluids 26, 2460 (1983)] on the structure and growth of phase space density holes for psi = -q/sub i/phi/T/sub i/<1 is extended to psi>1. As in the psi<1 case, it is found that reflecting electrons cause the ion holes to decelerate and grow, although the details are quite different. The reflected electrons cause the formation of a so-called "double layer." It is shown that isolated (intermittent) ion holes or wave packets can grow to much larger amplitudes than that predicted by the conventional quasilinear plateau limitation or Manheimer's [Phys. Fluids 14, 579 (1971)] trapping criteria.

33327 **Electromagnetic solitary vortices in a rotating plasma.** Liu, J.; Horton, W. (Department of Physics and The Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712). *Physics of Fluids;* **29**: No. 6, 1828-1835(Jun 1986). Contract FG05-80ET53088.

The nonlinear equations describing drift-Alfven solitary vortices in a low β, rotating plasma are derived. Two types of solitary vortex solutions along with their corresponding nonlinear dispersion relations are obtained. Both solutions have the localized coherent dipolar structure. The first type of solution belongs to the family of the usual Rossby or drift wave vortex, while the second type of solution is intrinsic to the electromagnetic perturbation in a magnetized plasma and is a complicated structure. While the first type of vortex is a solution to a second-order differential equation the second one is the solution of a fourth-order differential equation intrinsic to the electromagnetic problem. The fourth-order vortex solution has two intrinsic space scales in contrast to the single space scale of the previous drift vortex solution. With the second short scale length the parallel current density at the vortex interface becomes continuous. As special cases the rotational electron drift vortex and the rotational ballooning vortex also are given.

33328 **Finite-Larmor-radius dispersion functional for the Vlasov-fluid model.** Lewis, H.R. (Los Alamos National Laboratory, MS-F642, Los Alamos, New Mexico 87545). *Physics of Fluids;* **29**: No. 6, 1860-1871(Jun 1986).

A dispersion functional for the Vlasov-fluid model is derived as a finite-Larmor-radius (FLR) expansion in which the eigenfrequency is not assumed to be small compared to the ion gyrofrequency and secularities in the gyrophase angle never occur. The expansion is carried out in the local $E_0 \times B_0$ drift frame. Use of the dispersion functional for calculating the small-signal response of a plasma is compared to using an approximate dispersion differential equation. The linearized Vlasov-fluid model is examined with particular reference to the questions of treating the initial-value problem correctly and specifying a generally valid gauge condition. Calculational details for applying the dispersion functional to a general linear screw pinch are presented.

33329 **A generalized reduced fluid model with finite ion-gyroradius effects.** Hsu, C.T.; Hazeltine, R.D.; Morrison, P.J. (Institute for Fusion Studies, The University of Texas, Austin, Texas 78712). *Physics of Fluids;* **29**: No. 5, 1480-1487(May 1986). Contract FG05-80ET53088.

Reduced fluid models have become important tools for studying the nonlinear dynamics of plasma in a large aspect-ratio tokamak. A self-consistent nonlinear reduced fluid model, with finite ion-gyroradius effects is presented. The model is distinctive in being correct to O((rho/sub i//a)^2) and in satisfying an exact, relatively simple energy conservation law.

33330 **Toroidal viscosity and ambipolarity in the neoclassical transport theory of axisymmetric tori.** Catto, P.J. (Science Applications International Corporation, Plasma Research Institute, 1515 Walnut Street, Boulder, Colorado 80302). *Physics of Fluids;* **29**: No. 5, 1587-1601(May 1986). Contract AC03-76ET53057.

To self-consistently evaluate both the toroidal rotation and the radial electric field in a tokamak the two distinct constraints of toroidal angular momentum conservation and ambipolarity must be invoked. A gyrokinetic derivation of the neoclassical transport equations that permits a large toroidal rotation speed is employed. Explicit forms for the toroidal viscosity are obtained so that both constraints can be imposed. To keep the E x B drift speed smaller than the ion thermal speed and still consider large toroidal rotation, the ratio of the poloidal to toroidal magnetic field components is assumed to be small. For larger poloidal fields the derivation is restricted to small rotation. In general, it is also found necessary to retain the poloidal variations in the electrostatic potential and density. A tokamak plateau regime calculation is performed using the general formulation and illustrates the importance of retaining finite poloidal gyroradii effects.

33331 Ion viscosity stabilization of resistive internal kink modes. Porcelli, F.; Migliuolo, S. (Scuola Normale Superiore, Pisa, Italy and Massachusetts Institute of Technology, Cambridge,Massachusetts 02139). *Physics of Fluids;* **29**: No. 5, 1741-1743(May 1986). Contract AC02-78ET51013.

The linear stability theory of resistive $m^0 = 1$ internal kink modes is presented, including the effects of finite electron drift frequency, finite ion Larmor radius, and ion viscosity. Analytic and numerical computations are used to show that moderate values of the ion viscosity parameter are sufficient to stabilize the resistive internal kink mode.

33332 Statistical properties and correlation functions for drift waves. Horton, W. (Institute for Theoretical Physics, University of California, Santa Barbara, California 93106; Department of Physics, University of Texas, Austin, Texas 78712). *Physics of Fluids;* **29**: No. 5, 1491-1503(May 1986). Contract FG05-80ET53088.

The dissipative one-field drift wave equation is solved using the pseudospectral method to generate steady-state fluctuations. The fluctuations are analyzed in terms of space-time correlation functions and modal probability distributions. Nearly Gaussian statistics and exponential decay of the two-time correlation functions occur in the presence of electron dissipation, while in the absence of electron dissipation long-lived vortical structures occur. Formulas from renormalized, Markovianized statistical turbulence theory are given in a local approximation to interpret the dissipative turbulence.

33333 Electromagnetic hot plasma modes in a dense plasma near the second harmonic electron-cyclotron frequency. Matsuda, K. (GA Technologies Inc., San Diego, California 92138). *Physics of Fluids;* **29**: No. 5, 1602-1607(May 1986). Contract AC03-84ER53158.

Obliquely propagating electromagnetic hot plasma modes near the second harmonic electron-cyclotron frequency have been studied for a plasma of density around the cutoff density of the ordinary mode using the nonrelativistic dispersion equation. There are several branches of new electromagnetic hot plasma modes in the frequency region of 5% to 20% less than the second harmonic frequency. They are quite similar to the new modes near the fundamental frequency reported recently. There are two branches of the extraordinary mode. At the limit of small perpendicular wavenumber, one of the branches becomes a right wave of the hot plasma dispersion, and the other becomes either a left wave or a plasma wave.

33334 Parabolic approximation method for fast magnetosonic wave propagation in tokamaks. Phillips, C.K.; Perkins, F.W.; Hwang, D.Q. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *Physics of Fluids;* **29**: No. 5, 1608-1619(May 1986). Contract AC02-76CH03073.

Fast magnetosonic wave propagation in a cylindrical tokamak model is studied using a parabolic approximation method in which poloidal variations of the wave field are considered weak in comparison to the radial variations. Diffraction and wave interference effects, which are ignored by ray tracing methods, are included self-consistently using the parabolic method since continuous solutions for the wave electromagnetic fields are computed directly from an approximate form of the wave equation. Numerical results are presented which illustrate the cylindrical convergence of the launched waves into a diffraction-limited focal spot on the cyclotron absorption layer near the magnetic axis for a wide range of plasma confinement parameters.

33335 Analytic theory of the nonlinear m = 1 tearing mode. Hazeltine, R.D.; Meiss, J.D.; Morrison, P.J. (Institute for Fusion Studies, The University of Texas at Austin, Austin, Texas 78712-1068). *Physics of Fluids;* **29**: No. 5, 1633-1639(May 1986). Contract FG05-80ET53088.

Numerical studies show that the m = 1 tearing mode continues to grow exponentially well into the nonlinear regime, in contrast with the slow, "Rutherford," growth of m>1 modes. A single helicity calculation is presented which generalizes that of Rutherford [Phys. Fluids 16, 1903 (1973)] to the case when the constant-psi approximation is invalid. As in that theory, the parallel current becomes an approximate flux function when the island size W exceeds the linear tearing layer width. However, for the m = 1 mode, W becomes proportional to δB, rather than (δB)¹/sup //³ above this critical amplitude. This implies that the convective nonlinearity in Ohm's law, which couples the m = 0 component to the m = 1 component, dominates the resistive diffusion term. The balance between the inductive electric field and this convective nonlinearity results in exponential growth. Assuming the form of the perturbed fields to be like that of the linear mode, we find that growth occurs at 71% of the linear rate.

33336 Generation of high magnetic fields using a gas-puff Z pinch. Wessel, F.J.; Felber, F.S.; Wild, N.C.; Rahman, H.U.; Fisher, A.; Ruden, E. (JAYCOR, P. O. Box 85154, San Diego, California 92138-9259). *Applied Physics Letters;* **48**: No. 17, 1119-1121(28 Apr 1986). Contract FG03-84ER13302.

The imploding plasma column of a gas-puff Z pinch was used to compress an embedded axial magnetic field. Field compression ratios up to 180 times and peak compressed fields up to 1.6 MG were measured by Faraday rotation. Field compression by this method has the advantage of high repetition rate for applications in the controlled production of high-energy densities, solid-state studies, generation of short-wavelength radiation, reducing the ignition threshold for fusion, and particle acceleration.

33337 Consequences of time-reversal symmetry for the electric field scaling of transport in stellarators. Hirshman, S.P.; Shaing, K.C.; van Rij, W.I. (Fusion Energy Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *Physical Review Letters;* **56**: No. 16, 1697-1699(21 Apr 1986). Contract AC05-84OR21400.

Most three-dimensional fusion-plasma—confinement geometries possess symmetric magnetic fields satisfying B(theta,ξ) = B(-theta,-ξ) where theta and ξ are poloidal and toroidal flux coordinate angles, respectively. For such configurations with large aspect ratios, the time-reversal symmetry of the collisionless orbits is sufficient to prove that the local diffusion coefficient, D(E/sub r/), is independent of the sign of the radial electric field, E/sub r/. Consequences of this property for neutral-beam injection and for generic root-jumping models for stellarators are discussed.

33338 High-order spline interpolations in the particle simulation. Abe, H.; Sakairi, N.; Itatani, R.; Okuda, H. (Department of Electronics, Kyoto University, Kyoto 606, Japan). *Journal of Computational Physics;* **63**: No. 2, 247-267(Apr 1986). Contract AC02-76CH03073.

In the conventional plasma simulation models using particles, in which the total momentum is conserved, the total energy is not conserved due to nonuniformity of space caused by the spatial grids. The grid spacing has been severely limited of order of the Debye length. It is found that the use of the high-order spline spatial interpolation removes this limit without a significant increase of the computation and complexity of the algorithm in the system that only the long-wavelength, collective phenomena are important. The theoretical analysis of the total energy is improved compared with the previous work and its scaling law is related to the so-called aliasing error explicitly. The coefficient eta introduced previously is referred as the model index and is used again as a measure of the accuracy of the models for the energy conservation.

33339 Implicit moment electromagnetic plasma simulation in cylindrical coordinates. Wallace, J.M.; Brackbill, J.U.; Forslund, D.W. (Applied Theoretical Physics Division, Los Alamos National Laboratory, Los Alamos, New Mexico 87545). *Journal of Computational Physics;* **63**: No. 2, 434-457(Apr 1986).

An electromagnetic PIC plasma simulation code incorporating the implicit moment method and a two-dimensional cylindrical mesh, with r- and z-coordinate dependence, has been developed. The code is an extension of the VENUS code from the original two-dimensional Cartesian mesh. The physical model employed in the code will be discussed, with emphasis on aspects unique to cylindrical geometry. An application to self-generated magnetic fields

and electron transport in a laser-irradiated disk is presented that highlights the usefulness of cylindrical coordinates.

33340 A high-pressure ^{3}He gas scintillation neutron spectrometer. Derzon, M.S.; Slaughter, D.R.; Prassin, S.G. (Dept. of Nuclear Eng., Univ. of California, Berkeley, CA 94720). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-33**: No. 1, vp(Feb 1986). (CONF-851009—).

From IEEE nuclear science symposium; San Francisco, CA, USA (23 Oct 1985).

A high-pressure, ^{3}He-Xe gas scintillation spectrometer has been developed for neutron spectroscopy on D-D fusion plasmas. The spectrometer exhibits an energy resolution of (121 +- 20 keV) keV (FWHM) at 2.5 MeV and an efficiency of (1.9 +- 0.4) x 10^{-3} $(n/cm^2)^{-1}$. The contribution to the resolution (FWHM) from counting statistics is only (22 +- 3 keV) keV and the remainder is due predominantly to the variation of light collection efficiency with location of neutron events within the active volume of the detector.

33341 Observation of the 16.7 MeV D-T fusion gamma using a GaS Cerenkov detector. Ladish, J.S.; Toevs, J.W.; Young, C.S.; Nash, P.; Iversen, S.; Zagarino, P.; Jennings, L.; Seno, R.D. (Los Alamos National Lab., P.O. Box 1663, P-14 MS D410, Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-33**: No. 1, vp(Feb 1986). (CONF-851009—).

From IEEE nuclear science symposium; San Francisco, CA, USA (23 Oct 1985).

A measurement of the 16.7 MeV gamma production in a D-T fusion plasma was performed, using a four channel carbon dioxide gas Cerenkov detector system to measure the Cerenkov light generated by the gamma conversion electrons produced in a thin aluminum foil.

33342 Tokamak Fusion Test Reactor neutron source strength measurements instrumentation and results. Hendel, H.W. (Princeton Plasma Physics Lab., Princeton, NJ 08544). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-33**: No. 1, vp(Feb 1986). (CONF-851009—).

From IEEE nuclear science symposium; San Francisco, CA, USA (23 Oct 1985).

The Tokamak Fusion Test Reactor (TFTR) at Princeton University has been designed 1) to reach power break-even, Q ≃ 1 (Q = fusion power/heating power), in neutral-beam-injected, two-energy-component D-T plasmas, where the density confinement time requirement is less stringent than that for maxwellian, one-energy-component plasmas, and 2) to provide the physics understanding of reactor-like plasmas required for the development of tokamak reactors. TFTR has now been in operation for more than two years. Nearly 15,000 individual high power plasma discharges have been produced. Deuterium plasmas with ohmic heating currents up to 2.5 MA, deuterium neutral beam injection (NBI) with beam powers up to 6.3 MW (28 MW projected for 1986) and 80 KeV energy (120 KeV projected), deuterium pellet injection and adiabatic deuterium plasma compression have been investigated. The neutron source strength of a fusion plasma is a direct indicator of the fusion power generated. However, its measurement is complicated for a number of reasons. 1) The neutron source is extended and time varying. 2) It is surrounded by large, fixed scatterers near both source and detectors. 3) The dynamic range of interest in present experiments covers some ten orders of magnitude. In Section II the authors discuss briefly the plasma, its properties, the detectors, their useful ranges and limitations and their calibration. Section II contains some of the neutron measurement results obtained so far.

33343 Time resolved neutron spectrum measurements at the mirror fusion test facility. Slaughter, D. (Univ. of California, Lawrence Livermore National Lab., P.O. Box 808, L-405, Livermore, CA 94550). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-33**: No. 1, vp(Feb 1986). (CONF-851009—). Contract W-7405-ENG-48.

From IEEE nuclear science symposium; San Francisco, CA, USA (23 Oct 1985).

An advanced neutron diagnostic system has been developed for spectrum measurements on MFTF. Its collimated field of view allows spatially resolved neutron spectrum measurements. The 10 Mhz pulse height analysis and particle identification capability allow spectrum measurements in intervals as short as 10 ms. These capabilities will be used for space and time resolved determinations of ion energy from measurements of neutron Doppler width.

33344 Antenna analysis and boundary conditions for Alfven wave studies in tokamaks. Ross, D.W.; Li Yanming; Mahajan, S.M.; Michie, R.B. (Texas Univ., Austin, USA. Fusion Research Center). *Nuclear Fusion;* **26**: No. 2, 139-149(Feb 1986).

Previous studies of Alfven wave heating which employed kinetic theory are extended in order to take into account antenna configurations, in cylindrical geometry, consisting of arbitrary shell currents and their associated radial feeders. For each Fourier component of the form exp [-i(lzeta-mtheta)], the shell current consists of a divergence-free part having the helicity of the mode (l, m), plus an orthogonal part requiring the feeders. It is shown, both analytically and by including the full current in the numerical code, that only the divergence-free part of the current contributes significantly to the plasma response and antenna loading. The important effect of the feeders is to cancel the contribution from the surface current perpendicular to the helicity. This explicitly verifies results reported previously.

33345 Doublet III operating regimes with improved energy confinement. DeBoo, J.C.; Burrell, K.H.; Ejima, S.; Kellman, A.G.; Ohyabu, N.; Petrie, T.W.; Schissel, D.P.; Stambaugh, R.D. (GA Technologies, Inc., San Diego, CA, USA). *Nuclear Fusion;* **26**: No. 2, 211-221(Feb 1986).

Over the past three years, extensive energy confinement experiments have been performed on the Doublet III tokamak with up to 8 MW of both hydrogen and deuterium neutral beam heating power. These experiments covered a wide range of plasma parameters and almost a continuum of magnetic configurations from limited to fully diverted. It has been found that the global energy confinement time is linearly proportional to the plasma current and decreases with the application of neutral beam power for all configurations and beam species studied. The majority of our confinement experiments were conducted with discharges limited toward the outside of the vacuum vessel and heated with hydrogen neutral beams. With respect to this standard operating mode, several operating regimes were found with improved values of energy confinement time. Generally, deuterium neutral beam heating is superior to hydrogen beam heating and divertor operation yields superior confinement as compared to limiter operation. Our experiments also indicate that discharges limited toward the inside of the vacuum vessel exhibit somewhat better confinement relative to discharges limited toward the outside. Accordingly, the highest energy confinement values are obtained in high current, well diverted, deuterium beam heated discharges. Deuterium beam heated discharges limited toward the inside yield normalized energy confinement values similar to those from hydrogen beam heated divertor discharges.

33346 Basic principle of constant qsub(a) current buildup in tokamaks. Kikuchi, M. (Princeton Univ., NJ, USA. Plasma Physics Lab.). *Nuclear Fusion;* **26**: No. 2, 223-226(Feb 1986).

An analytic expression is derived in which the current profile shape in tokamaks is kept constant during the current buildup phase. The required conductivity profile is parametrized by two externally controllable parameters, I radicalsub(p) and a radicalsub(p), in the case of a Gaussian current profile. It is shown that a Gaussian current profile can be maintained, even under the condition of high I radicalsub(p), for a realistically broad conductivity profile by using the constant qsub(a) current buildup method.

33347 **Diagnosis of mildly relativistic electron distributions by cyclotron emission.** Hutchinson, I.H.; Kato, K. (Massachusetts Inst. of Tech., Cambridge, USA. Plasma Fusion Center). *Nuclear Fusion;* **26**: No. 2, 179-191(Feb 1986).

It is shown that electron cyclotron emission can be used for detailed diagnosis of mildly relativistic electron distribution functions, provided the plasma can be viewed along a line of constant magnetic field. Calculations of the emissivity are performed, both for tenuous and finite-background-density plasmas whose results allow observations of emission to be deconvolved in terms of the density and anisotropy of the distribution as a function of total electron energy. For prolate distributions different harmonics have to be measured, while for oblate distributions different polarizations have to be measured. Absorption can also be treated using these results. Some of the issues concerning experimental application are discussed.

33348 **Measurement of thermal transport by synchronous detection of modulated electron heating in the Doublet III tokamak.** Jahns, G.L.; Wong, S.K.; Prater, R.; Lin, S.H.; Ejima, S. (GA Technologies, Inc., San Diego, CA, USA). *Nuclear Fusion;* **26**: No. 2, 226-231(Feb 1986).

The power from 60 GHz gyrotrons was square-wave modulated to produce periodic temperature perturbations in a Doublet III discharge. The modulated component of the resulting soft-X-ray signals was isolated by digital processing and synchronous detection using the modulation as reference. The phase shift of the signals as a function of radius agrees well with a model calculation based on the heat balance equation, allowing thermal diffusivity to be determined and demonstrating the efficacy of this technique.

33349 **Toroidal heliac equilibrium.** Strauss, H.R.; Monticello, D.; Park, W. (New York Univ., NY, USA. Courant Inst. of Mathematical Sciences; Princeton Univ., NJ, USA. Plasma Physics Lab.). *Nuclear Fusion;* **26**: No. 2, 163-169(Feb 1986).

An expansion method is developed for long-wavelength heliac and stellarator equilibrium. Time-dependent equations of motion are solved numerically to give equilibria which can include magnetic islands and stochastic field regions. Analytic low-beta equilibria are found which are in good agreement with computations.

33350 **Zero-dimensional study of the compression of low-temperature spheromaks.** Meyerhofer, D.D.; Hulse, R.A.; Zweibel, E.G. (Princeton Univ., NJ, USA. Plasma Physics Lab.). *Nuclear Fusion;* **26**: No. 2, 235-241(Feb 1986).

Compression of low-temperature spheromak plasmas has been studied with the aid of a zero-dimensional two-fluid computer code. The major direct effect of compression is to raise the current and plasma densities, keeping their ratios constant. Above critical pre-compression values of the electron temperature, Tsub(e), and the product of electron density and particle confinement time, nsub(e)tausub(p), the rising plasma density shifts the impurity ions to higher ionization states, with correspondingly lower radiative losses. High post-compression temperatures may thus be achieved. In oxygen radiation-dominated plasmas with pre-compression values above the critical ones, and with constant tausub(p), the electron temperature can be increased by up to a factor of seven for a compression of a factor of two. This can be compared with a factor-of-four temperature rise expected for adiabatic compression. If the energy balance is dominated by particle confinement losses rather than radiation losses, the effect of compression is to raise the temperature as Tsub(e) approx. = Csup(6/5), for constant tausub(p).

33351 **Electromagnetic emission from a neutral-beam-injected plasma.** Bhadra, D.K.; Chiu, S.C.; Buchenauer, D.; Hwang, D. (GA Technologies, Inc., San Diego, CA, USA; Princeton Univ., NJ, USA. Plasma Physics Lab.). *Nuclear Fusion;* **26**: No. 2, 201-209(Feb 1986).

Results obtained from experiments in PDX with neutral beam injection show the emission of several harmonics of a frequency centred in the ion cyclotron frequency range. The structure of the magnetic signals registered is suggestive of an electromagnetic ion cyclotron type instability. A theory is developed for explaining the generation of neutral-beam-driven ion cyclotron instability (ion Bernstein mode) and the results are compared with the experimental data. An increase in beam density towards the outside of the plasma is possible if the beam ion population in that region increases owing to either counter-injection orbits or 'fishbone' effects. A calculation is made of the threshold density necessary to drive such an instability in a plasma with anisotropic beam ion distribution, and the effects due to the curvature drift of hot ions are included. The quasi-linear evolution of the beam is studied in order to understand possible beam isotropization and spreading in velocity space.

33352 **Physics of burn in magnetized deuterium-tritium plasmas: Spherical geometry.** Jones, R.D.; Mead, W.C. (Los Alamos National Lab., NM, USA). *Nuclear Fusion;* **26**: No. 2, 127-137(Feb 1986).

There is a large region of density-temperature space in which the effects of a magnetic field on heat transport and alpha-particle mobility are significant and the magnetic pressure is small compared with the pressure of a deuterium-tritium plasma. Spherical fusion burn in this regime is examined. It is found that for volume burn, magnetic fields can greatly increase the yield. In regimes where propagating burn does not occur, the burn can be enhanced by a magnetic field. In regimes where propagating deflagration would normally occur in the absence of a magnetic field, magnetic fields actually degrade the cross-field propagation. A detonation wave is harder to ignite in the presence of a magnetic field. Once a detonation wave is ignited, no change in the propagation speed is produced by applying a magnetic field.

33353 **Prospects for high power gyrotrons.** Kreischer, K.E.; Danly, B.G.; Saito, H.; Schutkeker, J.B.; Temkin, R.J.; Tran, T.M. (Massachusetts Inst. of Tech., Cambridge, USA. Plasma Fusion Center). *Plasma Physics and Controlled Fusion;* **27**: No. 12A, 1449-1459(Dec 1985). (CONF-8506270—).

From 12. annual conference of Plasma Physics Group of the Institute of Physics; Glasgow, UK (26 Jun 1985).

The prospects for electron cyclotron resonance heating (ECRH) and high power, high frequency gyrotrons are examined. Recent experimental and theoretical progress at MIT on the development of gyromontrons and gyroklystrons is described. It is shown that CW gyrotrons capable of MW powers and high efficiency are consistent with the technological constraints of the device. The design parameters of 1 and 10 MW, 120 GHz monotrons are given. An ECRH system based on such RF sources is described and compared with alternative plasma heating techniques.

33354 **Nonlinear theory of large-mode-number ballooning modes in fully toroidal geometry.** Mondt, J.P.; Weiland, J. (Los Alamos National Lab., NM, USA; Chalmers Univ. of Tech., Goeteborg, Sweden. Inst. for Electromagnetic Field Theory and Plasma Physics). *Journal of Plasma Physics;* **34**: 143-161(Aug 1985).

A nonlinear model equation describing ballooning modes for β of the order of the inverse aspect ratio and including magnetic shear is derived. For the special case of circular concentric flux surfaces, we obtain an approximate dispersion relation, including finite Larmor radius effects, and show the possibility of explosive instability in the nonlinear regime. The results are shown to remain valid in the presence of a low-density hot-ion constituent.

33355 **Electromagnetic solitary waves in magnetized plasmas.** Hazeltine, R.D.; Holm, D.D.; Morrison, P.J. (Texas Univ., Austin, USA. Inst. for Fusion Studies; Los Alamos National Lab., NM, USA; Texas Univ., Austin, USA. Dept. of Physics). *Journal of Plasma Physics;* **34**: 103-114(Aug 1985).

A Hamiltonian formulation, in terms of a non-canonical Poisson bracket, is presented for a nonlinear fluid system that includes reduced magnetohydrodynamics and the Hasegawa-Mima equation as limiting cases. One class of steady-state solutions is shown to provide a simple electromagnetic generalization of drift-solitary waves.

33356 **Stellarator to fusion plasma confinement.** Harris, J.H. (Oak Ridge National Lab., TN). *Energy Technology (Washington, D.C.);* **12**: 1082-1094(Aug 1985). (CONF-850301—). Contract AC05-84OR21400.

From 12. annual energy technology conference and exposition; Washington, DC, USA (25 Mar 1985).

The stellerator is a toroidal fusion plasma confinement device with nested magnetic flux surfaces, which offers the prospect of steady-state operation without plasma current. The required twist of the field lines is produced by external helical coils rather than by plasma current. The results achieved at Japanese and West German laboratories have made stellarator devices second only to tokamaks in progress toward fusion plasma conditions. The Advance Toroidal Facility (ATF) under construction at Oak Ridge National Laboratory and scheduled to operate in 1986 represents a significant advance. The ATF torsatron has been designed to operate steady state at high beta with good transport properties and to have sufficient flexibility to explore a wide variety of toroidal configurations, thereby contributing to the development of toroidal fusion reactors. 19 references, 3 figures.

33357 **Effects of Alfven Wave Heating on both confinement and impurities.** de Chambrier, A.; Collins, G.A.; Joye, B.; Lister, J.B.; Moret, J.; Nowak, S. (Association Euratom-Confederation Suisse, Centre de Recherches en Physique des Plasmas, EPFL 21, av. des Bains, CH-10007 Lausanne/ Switzerland). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 8-11(Jul 1985). (CONF-8505130—).

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Experiments on Alfven Wave Heating are being carried out on TCA at a power level up to the ohmic heating power, and with a pulse length of 30-60 msec. The applied frequency is 2.5 MHz. There is substantial heating of both electrons and ions, and a detailed power balance suggests that the heating rate is comparable with the RF power delivered by the antennae. There is a large increase in plasma density during the RF, which can reach +300% in some conditions. This density increase is insensitive to the machine conditioning. There is an increase in the radiated power loss from the plasma centre without the lateral screens, and we show that this is independent of the number of antennae used.

33358 **ICRF heating experiments on the PLT tokamak.** Wilson, J.R. (Princeton Plasma Physics Laboratory, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 28-31(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

The PLT ICRF heating program is exploring the stability, confinement and heating properties of ICRF as applied to the PLT plasma. In the deuterium majority, ^{3}He minority mode a T/sub d/ = 5 keV, n-bar/sub e/ = 3.7 x 10^{13} cm^{-3}, E>100 kJ plasma has been obtained with the application of 4.25 MW of coupled ICRF power. In the deuterium majority, hydrogen minority regime direct second harmonic majority heating has been observed. Optimization studies including pellet injection are underway. Experiments with direct ion Bernstein wave (IBW) heating in both the minority heating regime and single ion regime are underway.

33359 **New concepts for drift pumping a thermal barrier with RF.** Barter, J.D.; Baldwin, D.; Chen, Y.; Poulsen, P. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 36-39(Jul 1985). (CONF-8505130—). Contract W-7405-ENG-48.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

New concepts for drift pumping a thermal barrier with RF in TMX device are proposed.

33360 **Fast wave current drive.** Goree, J.; Ono, M.; Colestock, P.; Horton, R.; McNeill, D.; Park, H. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 65-66(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Experiments on the fast wave in the range of high ion cyclotron harmonics in the ACT-1 device show that current drive is possible with the fast wave just as it is for the lower hybrid wave, except that it is suitable for higher plasma densities. A 140° loop antenna launched the high ion cyclotron harmonic fast wave [ω/Ω = O(10)] into a He^+ plasma with n/sub e/≅4 x 10^{12} cm^{-3} and B = 4.5 kG. Probe and magnetic loop diagnostics and FIR laser scattering confirmed the presence of the fast wave, and the Rogowski loop indicated that the circulating plasma current increased by up to 40A with 1 kW of coupled power, which is comparable to lower hybrid current drive in the same device with the same unidirectional fast electron beam used as the target for the RF. A phased antenna array would be used for FWCD in a tokamak without the E-beam.

33361 **Comparison of bounce-averaged quasilinear theory with charge exchange measurements during minority fundamental and majority second harmonic ICRF heating in PLT.** Hammett, G.W.; Colestock, P.L.; Gammel, G.; Goldston, R.J.; Hosea, J.C.; Hwang, D.Q.; Kaita, R.; Ono, M.; Roquemore, L.; Wilson, J.R. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 67-70(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Previous studies in PLT using charge-exchange, edge probe, and fusion product diagnostics all indicate that ICRF tends to produce energetic trapped particles whose banana tips are near the resonance layer. A bounce-averaged quasilinear operator which predicts this "resonance localization" has been implemented in a Fokker-Planck code in order to make detailed comparisons with measurements. Good agreement is found with data from the horizontally-scanning, mass-resolving, charge-exchange analyzer, although the RF power profile seems to be broader than expected. We have recently observed a deuterium tail during hydrogen minority heating. The shape of this tail and its scaling with RF power agree well with the quasilinear theory. These measurements indicate that as much as 30% of the central RF power goes into direct second harmonic deuterium heating.

33362 **Resonance localization in tokamaks excited with ICRF waves.** Kerbel, G.D.; McCoy, M.G. (National Magnetic Fusion Energy Computer Center, Lawrence Livermore National Laboratory). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 75-78(Jul 1985). (CONF-8505130—). Contract W-7405-ENG-48.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

A bounce averaged Fokker-Planck quasilinear computational model which evolves the population of particles on more realistic orbits is developed.

33363 **ICRF heating of passing ions in a thermal barrier tandem mirror.** Molvik, A.W.; Dimonte, G.; Campbell, R.; Barter, J.; Cummins, W.F.; Falabella, S.; Poulsen, P. (Lawrence Livermore National Laboratory, University of California, Livermore, California 94550). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 79-82(Jul 1985). (CONF-8505130—). Contract W-7405-ENG-48.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

ICRF heating of the TMX-U central cell in two limits, isotropic and anisotropic, is reevaluated.

33364 The MICADO-A Multi-ion species confinement analysis code for ICRF and IBW heating experiments. Ono, M.; Colestock, P.; Wilson, J.R.; Bell, R.; Bitter, M.; Cavallo, A.; Hammett, G.; Hosea, J.; Hwang, D.; Kaita, R. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 83-86(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

A multi-ion species confinement analysis code (MICADO) has been developed for the PLT ICRF and Ion Bernstein Wave (IBW) heating experiments. For ICRF heating, the power is assumed to be absorbed by a minority ion species whose velocity distribution is determined using a one-dimensional velocity space diffusion equation in a multi-ion species background plasma. For the IBW heating, the power deposition profile is obtained from a ray-tracing calculation. The power is absorbed by the perpendicular-component of the heated ion species which produces an effective T/sub perpendicular/. The power flow into electrons and various ion species (including impurity ions) are calculated in each spatial grid. The self-consistent one-dimensional ion energy transport equations are solved for each ion species using an iterative procedure. The modeling code is found to agree well with many of the ion heating features observed in the PLT ICRF and IBW heating experiments.

33365 Role of ion Bernstein waves in ICRF experiments. Skiff, F.; Ono, M.; Wong, K.L. (Princeton University). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 91-95(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

The influence of the ion Bernstein wave, both parasitic and direct, on wave excitation in the ion cyclotron frequency range is presented. Excitation of ion Bernstein waves from electromagnetic loop antennas polarized to produce either B_0 or B/sub z/ is sstudied both in theory and experiment. Local analysis is applied to the Maxwell equations to include the effect of a density gradient which has a scale length comparable to the wavelength. The antenna is composed from a Fourier sum in the directions transverse to the gradient. Results of experiments on the ACT-I research torus are presented for comparison with theory. Both linear and parametric excitation are observed. In each case the excitation process is studied over a range of plasma density, and wave frequency and parallel wavenumber.

33366 Fast magnetosonic wave propagation and absorption in Tokamaks. Phillips, C.K.; Perkins, F.W.; Hwang, D.Q. (Plasma Physics Laboratory, Princeton University). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 99-102(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Fast magnetostatic wave propagation and absorption in a tokamak model consisting of an axially symmetric cylindrical plasma column with a radially varying density profile is considered.

33367 Energy confinement studies of lower hybrid current driven discharges in the Alcator C tokamak. Knowlton, S.; Bonoli, P.; Fiore, C.; McCool, S.; McDermott, S.; Porkolab, M.; Takase, Y.; Texter, S. (Plasma Fusion Center, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 122-130(Jul 1985). (CONF-8505130—). Contract AC02-78ET51013.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

The energy confinement properties of purely RF-driven plasmas on Alcator C are being investigated by experimental measurements of the bulk electron and ion temperature profiles, and by numerical modelling of the lower hybrid wave propagation and thermal energy transport. Power balance studies are performed on plasmas with parameters n-bar/sub e/ = 3-7 x 10^{13} cm^{-3}, B = 7-11 T, I/sub p/ = 100-200 kA, and q(a)> or =8, and with RF powers up to 1 MW at 4.6 GHz. The temperature mesurements from RF-driven discharges are compared with those from similar ohmic discharges (identical current and density). The gross energy confinement time, defined by tau/sub E/^3/2 ($\Sigma \int$n/sub j/T/sub j/ dV)/P/sub i//sub n/, is lower in the RF-driven discharges than in the ohmic ones by a factor of 1.5 to 4, depending on the plasma conditions and RF power. While tau/sub E/ in ohmic discharges increases with density and is independent of the toroidal field, the confinement time in the RF-driven discharges decreases with RF power, is independent of density in the range n-bar/sub e/ = 3-7 x 10^{13} cm^{-3}, and increases with the toroidal magnetic field. The confinement degrades slightly with increasing current in both RF-driven and ohmic discharges. The code used to simulate these results employs a lower hybrid ray tracing package, a Fokker-Planck code for the evolution of the fast electron tail, and enhanced thermal transport models for auxiliary-heated plasmas. In the code simulations, more than 80% of the injected RF power is absorbed by electron Landau damping in the inner half of the plasma column, the remainder being dissipated by collisions near the plasma edge.

33368 Current profile shaping and elimination of sawteeth oscillations by lower hybrid current drive in the PLT tokamak. Chu, T.K.; Bell, R.; Bernabei, S.; Cavallo, A.; Hooke, W.; Hosea, J.; Jobes, F.; Meservey, E.; Motley, R.; Stevens, J. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 131-134(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Sawteeth oscillations, which exist in inductively driven discharges in tokamaks, are eliminated by launching additional lower hybrid wave power. At RF power levels beyond that required to eliminate the sawteeth oscillations, electron heating in the central region of the plasma is observed.

33369 Comparison of top and side launch of lower hybrid waves in the PLT tokamak. Bernabei, S.; Cavallo, A.; Chu, T.K.; Hooke, W.; Jobes, F.; Meservey, E.; Motley, R.; Stevens, J.; von Goeler, S.; Guharay, S. (Princeton University, Plasma Physics Laboratory, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 135-138(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

For identical 90° settings the side coupler of the PLT 2.45 GHz, 1 MW lower hybrid system is more efficient at driving current than the top coupler at densities between 1 and 2 x 10^{13} cm^{-3}. We interpret this to be a reflection of the toroidal n/sub parallel/ upshift introduced by top launch. Measurements with 90°/60° (side/top) phase setting produces identical ΔI, as predicted theoretically from the ray tracing code.

33370 Theoretical studies of lower hybrid current drive in the Alcator C tokamak. Bonoli, P.T.; Porkolab, M.; Englade, R. (Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 139-142(Jul 1985). (CONF-8505130—). Contract AC02-78ET51013.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Theoretical studies of lower hybrid current drive in the Alcator C tokamak using a simulation model is presented, the model incorporates a 1-D radial transport code to solve for the time evolution of the bulk plasma quantities.

33371 Complex geometric optics theory in an inhomogeneous plasma. Bravo-Ortega, A.; Glasser, A.H. (Department of Physics, Auburn University, Auburn, Alabama 36849). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 147-150(Jul 1985). (CONF-8505130—). Contract AS05-82ER53134.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

The geometric optics theory is applied to an inhomogeneous plasma in which the dielectric tensor is not necessarily Hermitian. A complex dispersion relation for a non-degenerate plasma is obtained as well as complex ray tracing and amplitude equations. From the amplitude equation is possible to identify and separate the focusing effects according to their effects on the plasma, e.g. those ones due to cutoffs and resonances. It is expected that this treatment will enable one to investigate the propagation of radio-frequency electromagnetic waves near the harmonics of the cyclotron frequency where the condition 'sigma-circumflex/sup H/ '<<sigma-circumflex/sup A/' is not satisfied.

33372 **Runaway electrons and plasma turbulence in current ramping by lower hybrid waves in tokamak plasmas.** Liu, C.S.; Chan, V.S.; Lee, Y.C. (GA Technologies Inc., San Diego, California 92138). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 155-157(Jul 1985). (CONF-8505130—). Contract AC03-84ER53158.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

The role of runaway electrons in current ramping by lower hybrid waves is discussed. The back emf induced by current ramping using lower hybrid waves produces runaway electrons at such a rate that the rate of change of the current carried by runaways can completely compensate the RF current ramp rate if runaways are well-confined. However, runaway electrons can also destabilize the oblique plasma waves due to their anisotropy. The resulting turbulence can greatly reduce the runaway production rate, enabling the current ramping rate to exceed the above limit.

33373 **Theory of the anomalous doppler instability during lower-hybrid current drive.** Luckhardt, S.C. (Plasma Fusion Center, M.I.T., Cambridge, Massachusetts 02139). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 158-161(Jul 1985). (CONF-8505130—). Contract AC02-78ET51013.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

An instability condition is derived for electrostatic waves obeying the dispersion relation $\omega = \omega/\text{sub p//sub e/k/sub parallel//k}$ using a two dimensional electron distribution function, f(v/sub parallel/,v/sub perpendicular/), appropriate for lower-hybrid current drive. It is found that when the raised plateau in f in the velocity range $v_1 < v/\text{sub parallel/} < v_2$ has a sufficiently large anisotropy, T/sub p//sub parallel/>T/sub p//sub perpendicular/, this mode can become unstable. If the plateau velocities satisfy the condition $v_2/v_1 > 1+\omega/\text{sub c//sub e//}\omega/\text{sub p//sub e/}$ then waves exist with phase velocities in the plateau region and these waves are most easily destabilized by the anomalous doppler resonance, ω-k/sub parallel/v/sub parallel/ = -ω/sub c//sub e/.

33374 **Frequency scaling of the lower-hybrid current drive density limit on the Versator II tokamak.** Mayberry, M.J.; Porkolab, M.; Chen, K.; Kaplan, R.D.; Luckhardt, S.C.; Rohatgi, R. (Plasma Fusion Center and Research Laboratory of Electronics, M.I.T., Cambridge, Massachusetts 02139). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 162-165(Jul 1985). (CONF-8505130—). Contract AC02-78ET51013.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

It is shown that the lower-hybrid current drive density limit can be raised significantly by increasing the frequency of the RF source, while leaving the plasma parameters the same.

33375 **RF ramp-up efficiency versus power.** Stevens, J.E.; Colestock, P.L.; Bernabei, S.; Chu, T.K.; Hooke, W.; Jobes, F.C.; Motley, R.; Meservey, E.; von Goeler, S. (Plasma Fusion Center, MIT). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 178-181(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

The RF current ramp-up efficiency versus RF power in tokamak is studied theoretically.

33376 **Mode conversion of lower hybrid waves at high ion cyclotron harmonics.** Swanson, D.G.; Cho, S. (Physics Department, Auburn University, AL 36849). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 182-185(Jul 1985). (CONF-8505130—). Contract AS05-82ER53134.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

The problem of ion cyclotron harmonic absorption for a lower hybrid wave is shown to be a mode conversion problem. A new form of the dispersion relation is developed and then expanded to get a differential equation identical to that for the second harmonic problem. The validity of this model is restricted to the region far from the lower hybrid resonance layer. It is shown that mode couplings occur among the incident cold wave and two other waves, and the tunneling factor becomes singular there.

33377 **Nonlinear lower hybrid wave depletion.** Wersinger, J.; Park, I. (Department of Physics, Auburn University, Auburn, Alabama 36849). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 194-197(Jul 1985). (CONF-8505130—). Contract AS05-82ER53134.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Two numerical ray tracing codes with focusing are used to compute lower hybrid daughter wave amplification by quasi-mode parametric decay. The first code, LHPUMP provides a numerical pump model on a grid. This model is used by a second code, LHFQM which computes daughter wave amplification inside the pump extent and follows the rays until their energy is absorbed by the plasma. An analytic model is then used to estimate pump depletion based on the numerical results. Results for PLT indicate strong pump depletion at the plasma edge at high density operation for the 800 Mhz wave frequency, but weak depletion for the 2.45 Ghz experiment. This is proposed to be the mechanism responsible for the high density limit for current drive as well as for the difficulty to heat ions.

33378 **Heating of electrons in a high density Tokamak by a micro-wave near second harmonic frequency.** Matsuda, K. (GA Technologies Inc., San Diego, California 92138). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 218-221(Jul 1985). (CONF-8505130—). Contract AC03-84ER53158.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Detailed numerical solutions for obliquely propagating electromagnetic waves near the second harmonic electron cyclotron frequency have been obtained for a plasma of density around the cutoff density of the ordinary mode (O-mode). In a tokamak plasma satisfying a relatively loose condition, a launched O-mode of moderate n/sub parallel/ pass through locations where several branches of electromagnetic hot plasma modes with large right hand components may exist; one of them is the branch of the extraordinary mode (X-mode) and others are new modes. Possibilities of electron heating through mode conversions to those modes are discussed.

33379 **Electron cyclotron heating at down-shifted frequencies in PLT and TFTR.** Mazzucato, E.; Fidone, I.; Giruzzi, G.; Krivenski, V. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 222-226(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

It is shown that the ECH at down shifted frequencies can be tested in present day totamaks with the existing microwave sources (GoGH/sub z/) or those under development (100GH/sub z/).

33380 **Study of the effect of localized ECH on transport and stability in plasmas.** Kritz, A.H.; Hsuan, H.; Cavallo, A.; McCune, D.; Mikkelsen, D.R.; Rutherford, P.H.; White, R.B. (PPPL Princeton University, Princeton, New Jersey 08544). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 235-242(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073;FG02-84ER53187.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

TORAY has been linked with the BALDUR and TRANSP transport codes in order to model the electron cyclotron heating that occurred in PDX. Results of simulation studies are presented, and electron transport in an ECH plasma is discussed. The simulation studies confirm the localized nature of ECH and indicate the possibility of controlling energy transport at the plasma center by localized heating or current drive.

33381 **ICRF heating in STM.** Talmadge, S.; Samec, T.K.; Lazar, N.H. (TRW Space and Technology Group, Redondo Beach, California 90278). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 103-106(Jul 1985). (CONF-8505130—). Contract AC03-79ET51017.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

A calibrated cesium cell charge exchange analyzer is used to diagnose the STM plasma heated at the fundamental ion cyclotron frequency (2.85MHz). Up to 25kW of RF power has been applied to an ECRH source plasma. High density ($\sim 1.5 \times 10^{13} cm^{-3}$) hot ion plasmas have been produced with strongly peaked radial profiles. The highest ion beta reached thus far is ~5% with no trend yet toward saturation.

33382 **Two-chamber model for divertors with plasma recycling.** Langer, W.D.; Singer, C.E. (Plasma Physics Laboratory, Princeton University, Princeton, NJ). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-13**: No. 3, 163-168(Jun 1985).

To model particle and heat-loss terms at the edge of a tokamak with a divertor or pumped limiter, a simple two-chamber formuluation of the scrapeoff has been constructed by integrating the fluid equations, including sources, along open field lines. The model is then solved for a wide range of density and temperature conditions in the scrapeoff, using geometrical parameters typical of the poloidal divertor in the poloidal divertor experiment (PDX). The solutions characterize four divertor operating conditions for beam-heated plasmas: plugged, unplugged, blowthrough, and blowback.

33383 **Bounds on instability growth rates for cold plasmas streaming along an infinite magnetic guide field.** Kadish, A.; Kriegsmann, G.; Lemans, D.S. (Los Alamos National Laboratory, Los Alamos, NM). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science;* **PS-13**: No. 3, 167-170(Jun 1985).

We derive two bounds on growth rates for streaming instabilities of cold plasmas with inhomogeneous density and velocity profiles transverse to a unidirectional infinite magnetic field: a uniform bound which is independent of wavenumber, and a wavenumberdependent bound which is less than the uniform bound for long wavelengths. Here streaming instabilities include both multistream instabilities in which two or more streams with different velocities overlap in configuration space, and the slipping stream instability in which a stream has a transverse velocity gradient. The bounds obtained are functions of only global steady-state parameters and are useful in bounding growth rates in experimental devices.

33384 **Calculation of RFP equilibrium in ZT-40M by finite-beta model.** Nagayama, Yoshio. (Los Alamos National Lab., NM, USA). *Japanese Journal of Applied Physics, Part 1: Regular Papers and Short Notes;* **24**: No. 5, 585-588(May 1985).

A simple finite-β model is proposed for calculating the reversed-field pinch (RFP) plasma equilibrium using the Grad-Shafranov equation, so as to extend the calculation to two dimensions; and the importance of the pressure profile effect on F and theta is pointed out. The equilibrium in the ZT-40M RFP plasma is obtained using this model by adjusting the parameters so that F, theta, βsub(ax), and the pressure profile are consistent with the experimental data. In high-theta operation, the sawtooth oscillation is found to be accompanied by changes in the field and current profiles.

33385 **Plasma radius control system for tandem mirrors.** Najmabadi, F.; Conn, R.W. (University of California at Los Angeles, Fusion Engineering and Physics Program, School of Engineering and Applied Science and Center for Plasma Physics and Fusion Engineering, Los Angeles, CA). *Fusion Technology;* **7**: No. 1, 57-65(Jan 1985).

The operation of a tandem mirror reactor (TMR) at fractions of full power is an important part of the power plant operation. It has been shown that fractional power operation can best be achieved by controlling the plasma radius, leaving the rest of plasma parameters unchanged. The physics of magnetic confinement in a TMR can be used to design the desired radius control (RC) system. It is proposed to bias the field lines through the ends of a tandem mirror device and control the radial electric field in order to guard against rotational instabilities and ensure nonstochastic radial transport. In this scheme, plasma on the unbiased field lines suffers rapid transport and is lost. As such, the potential control of the direct converter plates as well as the location of the grounded halo dumps requires the flux tube containing the core plasma to match the direct converter area at all times. Based on this effect, an RC system can be devised that uses the conservation of the magnetic flux to adjust the field near the direct converter such that a flux tube with a smaller radius in the device matches the direct converter. Field lines outside this flux tube are not properly biased and cannot support core plasma. A practical design of such an RC system for the Mirror Advanced Reactor Study conceptual TMR is presented. The power consumption by the RC coil system is modest and no engineering difficulty in the design and construction of such a system is expected. Utilization of such an RC system in advanced tandem mirror experiments can also be of great use in the study of such various phenomena as radial transport, control of the radial electric field, halo plasma production, radio-frequency absorption, etc.

33386 **1-1 1/2 computational using poloidal flux coordinates and an integral transform technique.** Olson, R.E.; Miley, G.H. (Fusion Studies Lab., Univ. of Illinois, Urbana, IL 61801). pp 731-742 of Proceedings of an international meeting on advances in nuclear engineering computational methods. Volume 2. LaGrange Park, IL; American Nuclear Society (1985). (CONF-850411—).

From International meeting on advances in nuclear engineering computational methods; Knoxville, TN, USA (9 Apr 1985).

A computational method for a "1-1/2" D treatment of plasma transport in a spheromak is described. The method uses poloidal flux coordinates with appropriate surface average quantities and introduces a new integral transform method for rapid solution of the 2-D equilibrium portion of the problem. An illustrative application describing the time evolution of the plasma in the pS-Ic experiment is presented.

33387 **Finite element solution of the Fokker-Planck equation in electrostatic magnetic mirror fusion machines.** Zerguini, T.H. (Fusion Studies Lab., Nuclear Eng. Program, Univ. of Illinois, Urbana, IL 61801). pp 743-758 of Proceedings of an international meeting on advances in nuclear engineering computational methods. Volume 2. LaGrange Park, IL; American Nuclear Society (1985). (CONF-850411—).

From International meeting on advances in nuclear engineering computational methods; Knoxville, TN, USA (9 Apr 1985).

A pertubation method is developed to find solutions of sloshing-ion distributions. This method uses an expansion in the ratio of electrostatic potential to average ion energy to simplify the bounce-averaged Fokker-Planck equation. Finite element techniques, which provide rapid numerical solutions for parametric studies of sloshing ions, are used to derive the zero-th order angular and velocity equations. The first order two-dimensional equation was also expanded into finite element "hat functions." Application of Galerkin's method gives a linear system of equations where all matrix and source elements are calculated analytically. The density

ratio and the potential profiles as functions of axial distance are computed. There is excellent agreement with results from the Lawrence Livermore National Laboratory bounce-averaged Fokker-Planck code with as much as 500 times and 50 times less CRAY-1 computer time for the zero-th order and first order solutions, respectively.

33388 **Semi-implicit method for 3D compressible resistive MHD simulation of fusion plasmas.** Harned, D.S.; Kerner, W. (Courant Inst. of Mathematical Sciences, NYU, New York). pp 800-811 of Proceedings of an international meeting on advances in nuclear engineering computational methods. Volume 2. LaGrange Park, IL; American Nuclear Society (1985). (CONF-850411—). Contract AC02-76ER03077.

From International meeting on advances in nuclear engineering computational methods; Knoxville, TN, USA (9 Apr 1985).

A semi-implicit method for solving the full compressible resistive MHD equations in three dimensions is presented. The method is designed for use in the modeling of fusion plasmas in magnetic confinement devices. The method is unconditionally stable with respect to the fast compressional modes. The time step is limited by the slower shear Alfven motion. The computing time required for one time step is essentially the same as that for explicit methods. The code is applied to resistive instabilities in cylindrical tokamak equilibria.

33389 **Wave-mixing from unexpected atomic transitions in laser generated plasma.** Wu, C.Y.R.; Xu, S.; Deng, H.; Yih, T.S. (Dept. of Physics and Space Sciences Center, Univ. of Southern California, Los Angeles, CA 90089-1341). pp 740-744 of Lasers '84. McLean, VA; STS Press (1984). (CONF-8411153—).

From International conference on lasers '84; San Francisco, CA, USA (26 Nov 1984).

In a study of the interaction of intense visible laser radiation with Na vapor the authors have observed tunable coherent UV radiation generated in the region of 3d→3s transition through four-wave mixing and that the efficiency of the transition is quite high. The tuning characteristics of the UV outputs and their dependences on the sodium vapor density and laser power density are presented.

33390 **Two-dimensional beat wave acceleration simulation.** Kindel, J.M.; Forslund, D.W.; Mori, W.B.; Joshi, C.; Dawson, J.M. (Los Alamos National Lab., P.O. Box 1663, Los Alamos, NM 87545). pp 462-466 of Lasers '84. McLean, VA; STS Press (1984). (CONF-8411153—).

From International conference on lasers '84; San Francisco, CA, USA (26 Nov 1984).

Finite laser beam particle simulations of beat wave acceleration show that a coherent plasma wave excited by two-colinear laser beams at a difference frequency equal to the plasma frequency can produce maximum electron energies as predicted by simple one-dimensional theory. The time to saturation and the saturation amplitude of the plasma wave electric field agrees with the Rosenbluth-Liu theory. Stimulated Raman scattering does not appear to degrade the electron acceleration process. Eventually self-focussing and filamentation limit the lifetime of the coherent plasma wave to tens of picoseconds for an intense CO_2 laser beam.

33391 **Experiments on the plasma beat wave accelerator at UCLA.** Joshi, C.; Clayton, C.E.; Darrow, C.; Umstadter, D. (Univ. of California, Los Angeles, CA 90024). pp 467-471 of Lasers '84. McLean, VA; STS Press (1984). (CONF-8411153—). Contract AS03-83ER40120.

From International conference on lasers '84; San Francisco, CA, USA (26 Nov 1984).

Recent experiments at UCLA on the excitation of a high-phase velocity plasma wave by beating two laser beams in a plasma such that their frequency difference equals the plasma frequency are described. Thomson scattering using a ruby laser probe is used to measure the plasma density as well as ion and electron modes. Stokes and Anti-Stokes radiation in the forward direction is used to infer the existance of the "fast" plasma wave.

33392 **Laser plasma LINAC.** Palmer, R.B.; Baggett, N.; Claus, J.; Fernow, R.; Ghosh, A.; Giordano, S.; Radeka, V.; Stumer, I.; Takacs, P.; Warren, J. (Brookhaven National Lab., Upton, NY 11973). pp 472-477 of Lasers '84. McLean, VA; STS Press (1984). (CONF-8411153—).

From International conference on lasers '84; San Francisco, CA, USA (26 Nov 1984).

The grating accelerator concept is reviewed. The use of a double row of conducting droplets instead of a conventional grating constrains the fields to a narrow band. The use of droplets also allows fields that will destroy the structure. RF modeling results are presented together with a simple theory of the fields. Coupling to incoming radiation is described. A possible laser specification is also given.

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33393 **(CONF-860170—1) Initial cost projections of CIT device options.** Hamilton, W.R. (Oak Ridge National Lab., TN (USA)). 20 Jan 1986. Contract AC05-84OR21400. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009503.

From Ignition Technical Oversight Committee meeting; Austin, TX, USA (20 Jan 1986).

Viewgraphs from the presentation are given. The cost estimating methodology is described. (MOW)

33394 **(CONF-860412—4) 3-D analysis on arbitrarily-shaped ICRF antennas and Faraday shields.** Chen, G.L.; Whealton, J.H.; Baity, F.W.; Hoffman, D.J.; Owens, T.L. (Oak Ridge National Lab., TN (USA); McDonnell Douglas Astronautics Co., St. Louis, MO (USA)). 1986. Contract AC05-84OR21400. 2p. NTIS, PC A02. File Number DE86010014.

From 13. European conference on controlled fusion and plasma heating; Schliersee, F.R. Germany (14 Apr 1986).

Cavity antennas with Faraday shields are proposed to couple ion cyclotron radio frequency power for heating fusion plasmas. This application requires small, high-power, low-frequency antennas. The results are presented of a theoretical study of the ICRF antennas being developed for this purpose at the Radio Frequency Test Facility (RFTF). The objectives of this work are to optimize experimental designs and to confirm test results. (MOW)

33395 **(CONF-860421—43) Near term and long term materials issues and development needs for plasma interactive components.** Mattas, R.F. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 26p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010518.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Plasma interactive components (PICs), including the first wall, limiter blades, divertor collector plates, halo scrapers, and RF launchers, are exposed to high particle fluxes that can result in high sputtering erosion rates and high heat fluxes. In addition, the materials in reactors are exposed to high neutron fluxes which will degrade the bulk properties. This severe environment will limit the materials and designs which can be used in fusion devices. In order to provide a reasonable degree of confidence that plasma interactive components will operate successfully, a comprehensive development program is needed. Materials research and development plays a key role in the successful development of PICs. The range of operating conditions along with a summary of the major issues for materials development is described. The areas covered include plasma/materials interactions, erosion/redeposition, baseline materials properties, fabrication, and irradiation damage effects. Candidate materials and materials development needs in the near term and long term are identified.

33396 **(CONF-860421—45) Thermal conductivity of mixed beryllia/Li ceramic in sphere-pac forms.** Tam, S.W.; Johnson, C.E. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010521.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Lithium containing ceramic tritium breeder materials have been envisaged to be deployed within the blanket region of a fusion reactor in several possible configurations. One of these is the sphere-pac configuration. For this configuration an important material parameter is its thermal conductivity (Ksp). It is well known that Ksp demonstrates rather complex behavior as a function of temperature, gas pressure, gas composition, particle size, and packing fraction. The inter-relationship of these parameters has been satisfactorily accounted for with a hierarchical effective media theory (HEMT). For tritium self sufficiency most lithium ceramic breeder materials would require the presence of a neutron-multiplier (e.g., Be or BeO). Here, the influence of configuration on Ksp (i.e., how one put the different solid components together in the sphere-pac bed) becomes important. Using a generalized HEMT (i.e., a model with capability to describe systems with more than one solid material component) we have analyzed in detail the configurational dependence of Ksp for sphere-pac beds composed of lithium ceramic/BeO microspheres. Substantial improvements in Ksp can be achieved if a configuration of lithium ceramic spheres coated with BeO is chosen.

33397 **(CONF-860421—46) Recent results on the preparation and properties of Li-containing Cu alloys.** Mendelsohn, M.H.; Gruen, D.M.; Krauss, A.R. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 15p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010495.

From 2. international conference on fusion reactor materials (ICFRM-2); Chicago, IL, USA (13 Apr 1986).

Homogeneous solid solutions of Li in copper have been prepared containing up to 6 to 8 at. % Li. However, the possible metastable nature of these materials has not yet been fully investigated. The existence of a unique intermetallic compound near the composition Cu_4Li is currently being investigated by single crystal x-ray diffraction and powder neutron diffraction techniques. The copper-lithium binary alloy has demonstrated potential as a means of forming a self-sustaining coating for the reduction of sputtering-induced erosion in fusion applications. The initial performance under high flux conditions is strongly dependent on the lithium content and method of preparation.

33398 **(CONF-860610—17) Overview of the FEDC Compact Ignition Tokamak program.** Flanagan, C.A. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 6p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86007229.

From American Nuclear Society annual meeting; Reno, NV, USA (15 Jun 1986).

The Fusion Engineering Design Center (FEDC) has developed an alternate version of the Ignitor design as a candidate option for the US Compact Ignition Tokamak program. The Ignitor concept has been advocated for several years as a concept to achieve ignition in a compact size using state-of-the-art technology and deriving significant contribution toward ignition from ohmic heating. The projected incremental cost, assuming siting at the Princeton Plasma Physics Laboratory, appears attractive.

33399 **(CONF-8603116—1) Analysis of the FELIX experiments with cantilevered beams and hollow cylinders.** Turner, L.R.; Hua, T.Q.; Lee, S.Y. (Argonne National Lab., IL (USA)). 1986. Contract W-31-109-ENG-38. 44p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010528.

From 4. eddy current seminar; Chilton, UK (24 Mar 1986).

Experiments have been performed with the FELIX facility at Argonne National Laboratory to study the coupling between eddy currents and deflections and to provide data for validating eddy current computer programs. Experiments with cantilevered beams in crossed steady and decaying magnetic fields verify that coupling effects act to alleviate the large currents, deflections, and stresses predicted by uncoupled analyses. Measurements of magnetic fields induced in conducting hollow cylinders are analyzed by exponential fitting and by transfer functions. Spatial variation in the parameters of the exponential fit and in those of the one- and two-pole transfer functions suggests that several eddy current modes are acting in the cylinder test pieces.

33400 **(CONF-8604175—1) Panel discussion on prospects for fusion power.** Sheffield, J. (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 5p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010035.

From Fusion Power Associates symposium on fusion energy development: an international effort; Washington, DC, USA (24 Apr 1986).

Although substantial progress is made every year in fusion research, the projected time to realize the ultimate goal of commercial fusion always seems to be 25 to 30 years away. This shifting schedule reflects the underlying difficulty of developing fusion. Every new technology improves the prospects for success, yet as each fusion mountain is scaled, it serves mainly to bring a better view of the next mountain. Two questions are considered: (1) why are so many configurations studied, and (2) what constitutes an economic power density.

33401 **(DOE/ER—0046/23) Damage analysis and fundamental studies. Quarterly progress report, July-September 1985.** (Hanford Engineering Development Lab., Richland, WA (USA)). Nov 1985. Contract AC06-76FF02170. 78p. NTIS, PC A05/MF A01; 1; GPO Dep. File Number DE86010232.

Separate abstracts were prepared for 8 of the included sections. (MOW)

33402 **(GA-A—18341) End of three-year contract report on the RFC-XX-M device research, Nagoya, Japan, March 1, 1983-December 31, 1985.** Garner, H.R. (GA Technologies, Inc., San Diego, CA (USA)). Apr 1986. Contract AC03-83SF11713. 30p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010669.

RFC-XX-M is a large cusp end celled, totally axisymmetric tandem mirror located at the Institute of Plasma Physics in Nagoya, Japan. The device was originally constructed to study rf pondermotive potential pluging and was built with funds from the Japanese Ministry of Education. In 1983, DOE awarded GA Technologies Inc. (GA) a contract to study the physics of axisymmetric mirror plasmas and, through an international agreement, the GA group began to perform experiments on the device. The device has been modified and the experimental program expanded to respond to the needs of the international mirror program. Since then, a team of US scientists have been present at the experimental site for over 60% of the time. This report summarizes the achievements of this cooperative research program and the impact of those achievements on the US Mirror Program.

33403 **(IAE—4026/8) Study on the thermonuclear energy ion interaction with a surface of carbon containing structural materials for thermonuclear reactors.** Begrambekov, L.B.; Gerchikov, M.Yu.; Guseva, M.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1984. 40p. (In Russian). NTIS (US Sales Only), PC A03/MF A01. File Number DE86701952.

Sputtering of titanium, niobium and tantalum carbides coating the first wall of thermonuclear reactors has been investigated as well as massive carbon containing materials and compositions for electrodes in reactor systems of megawatt atom beams during their bombardment with 0.3-10 keV hydrogen, deuterium and helium ions at 100-160 deg C. Selective and total coefficients of cathode sputtering and dynamics of selective sputtering have been determined. The effect of the sputtering on the surface structure was observed. Energy and mass spectra of ion-ion emission and degassing kinetics of carbon-containing materials were studied. Change of the surface composition at heating and ion bombardment has been investigated. A near-surface layer with new properties: composition, structure and chemical bonds of atoms formed on the surface of carbon-containing materials due to ion bombardment and subsequent return of sputtered atoms. Use of some of the materials investigated as a renewed coating of the first tokamak-reactor wall or

structural material can lead to the decrease of the surface erosion rate and of radiation losses.

33404 **(IPP—1/236) Assessment of pellet injection for NET. Pt. 5. Ignition and fuelling scenario calculations.** Lengyel, L.L. (Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.)). Aug 1985. 54p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86751760.

Results of ignition and continuous fuelling scenario calculations are presented that were obtained in the framework of an assessment performed for NET on the basis of the INTOR parameters. The results obtained with pellet injection are compared with results corresponding to gas puffing. Pellet injection transports fresh fuel to the reaction zone on a time scale that is much shorter than the diffusion time characterizing the gas puffing method, thus making the method flexible and readily adaptable to different situations. In the case of ignition by pellet injection, it may become possible to have deep NB penetration and maintain favourable heat deposition profiles up to the moment of density ramp-up, thus substantially relaxing the beam output requirements. Three beam energies (D^0 particles) have been considered: 120 keV, 100 keV, and 80 keV. The importance of a proper match between the beam characteristics and the pellet parameters, specific for the transport scaling assumed (ALCATOR-INTOR), is shown. In the case of continuous fuelling of an already ignited discharge, the alpha power production notably increases if repetitive pellet injection, instead of gas puffing (at a fixed value of βsub(T)), is applied. The advantages of pellet injection are substantial even at moderate pellet velocities. (orig.).

33405 **(LA-UR—86-1299) Compact reversed-field pinch reactors (CRFPR).** Krakowski, R.A.; Miller, R.L.; Bathke, C.G.; Hagenson, R.L.; Copenhaver, C.; Werley, K.A. (Los Alamos National Lab., NM (USA); Phillips Petroleum Co., Bartlesville, OK (USA)). 1986. Contract W-7405-ENG-36. 19p. (CONF-860551—2). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010185.

From Technical meeting and workshop on fusion reactor design and technology; Yalta, USSR (26 May 1986).

The unique confinement properties of the Reversed-Field Pinch (RFP) are exploited to examine physics and technical issues related to a compact, high-power-density fusion reactor. This resistive-coil, steady-state, toroidal device would use a dual-media power cycle driven by a fusion power core (FPC, i.e., plasma chamber, first wall, blanket, shield, and coils) with a power density and mass approaching values characteristic of pressurized-water fission rectors. A 1000-MWe(net) base case is selected from a comprehensive trade-off study to examine technological issues related to operating a high-power-density FPC. After describing the main physics and technology issues for this base-case reactor, directions for future study are suggested.

33406 (LBL—19100, pp 28-34) **Neutral-beam development.** May 1985. NTIS, PC A05/MF A01. File Number DE85013314.

In Accelerator and Fusion Research Division: 1984 summary of activities.

Increasing attention is turning to negative ions as the source for intense neutral beams, principally because they can be efficiently neutralized even at high energies (above 150 keV/particle for deuterium). Nonetheless, one of the highlights of 1984 was the choice of an LBL positive-ion source as the common long-pulse source for experiments at TFTR, MFTF-B, and Doublet III in the coming years. In a series of 80-kV, 30-second tests at the Neutral Beam Engineering Test Facility, the LBL source produced an average current of over 40 A. Negative-ion source development continued to focus on two different designs. The surface-conversion source - the better understood of the two - can now be considered a practical tool, largely because of advances that allow us to effectively control cesium contamination. Development of the volume-production source also moved forward, notably in the areas of increasing the extracted current and reducing the electron content of the beam.

33407 **(ORNL/FEDC—86/1) Interim report on the assessment of engineering issues for compact high-field ignition devices.** Flanagan, C.A. (ed.). (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 157p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86010060.

The engineering issues addressed at the workshop included the overall configuration, layout, and assembly; limiter and first-wall energy removal; magnet system structure design; fabricability; repairability; and costs. In performing the assessment, the primary features and characteristics of each concept under study were reviewed as representative of this class of ignition device. The emphasis was to understand the key engineering areas of concern for this class of device and deliberately not attempt to define an optimum design or to choose a best approach. The assessment concluded that compact ignition tokamaks, as represented by the three concepts under study, are feasible. A number of critical engineering issues were identified, and all appear to have tractable solutions. The engineering issues appear quite challenging, and to obtain increased confidence in the apparent design solutions requires completion of the next level of design detail, complemented by appropriate development programs and testing.

33408 **(ORNL/M—156) Fusion Energy Division Annual Information Meeting. Agenda and abstracts, April 8-9, 1986.** (Oak Ridge National Lab., TN (USA)). 1986. Contract AC05-84OR21400. 49p. (CONF-8604182—Absts.). NTIS, PC A03/MF A01; GPO Dep. File Number DE86009975.

From Fusion energy division annual information meeting; Oak Ridge, TN, USA (8 Apr 1986).

Abstracts of the presentations are included. The general topics covered included the following: (1) development and technology, and (2) plasma confinement, theory, and FEDC. In addition, abstracts are also given for various invited talks. (MOW)

33409 **(SAIC—86/1606) Large mirror ratio tandem mirror magnetic design studies.** Francis, G.L.; Myra, J.R.; D'Ippolito, D.A.; Catto, P.J.; Aamodt, R.E. (Science Applications International Corp., Boulder, CO (USA). Plasma Research Inst.). Apr 1986. Contract AC03-76ET53057. 29p. (PRI—98). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010665.

A systematic study of magnetic designs has been carried out for three-cell quadrupole-stabilized tandem mirror reactors comparable in size to the (octupole) mini-MARS design. In these designs, a single mirror cell at each end of the device serves as end plug, thermal barrier and MHD anchor. The multiple functions of the end plugs make it difficult to simultaneously optimize the physics properties of the plasma (stability, radial confinement, and good particle drift orbits). Two different design approaches have been studied using recently developed magnetic optimization techniques. Typical physics figures of merit are given and critical issues discussed for each design.

33410 **(SAND—85-2623C) Local mixing model with sputtering/redeposition and projectile-implanted atom interaction.** Brice, D.K.; Wampler, W.R. (Sandia National Labs., Albuquerque, NM (USA)). 1986. Contract AC04-76DP00789. 19p. (CONF-860522—2). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010441.

From 7. international conference on plasma surface interactions in controlled fusion devices; Princeton, NJ, USA (5 May 1986).

A previously discussed local mixing model (LMM) accurately describes the buildup of implanted hydrogen to saturation concentration and subsequent isotope exchange for implantation into a variety of materials of interest to the fusion community. Sputtering and surface deposition were not initially included in this model. We have now incorporated into the LMM the effects of sputtering and target-atom redeposition and have also included (in an approximate fashion) the slowing and scattering of implanted ions by previously implanted impurity species. This latter effect has important consequences for high fluence implants. Equations are derived which govern the evolution of the depth profiles of the implanted species and a formal solution is given for conditions which often are en-

countered in laboratory experiments. The time (fluence) dependence of the depth profile is discussed, and numerical results are compared with experiment for oxygen implantation into graphite at energies for which surface erosion is a significant effect. Solutions to the equations are also discussed for cases in which surface redeposition is significant. These latter solutions are pertinent to impurity and hydrogen isotope buildup in first wall components in operating fusion reactors.

33411 **(UCRL—15751) Final report for TMX-U systems support.** (TRW, Inc., Cleveland, OH (USA)). 1985. Contract W-7405-ENG-48. 108p. NTIS, PC A06/MF A01; 1; GPO Dep. File Number DE86010565.

This final report is for the TMX-U RF systems development subcontract with Lawrence Livermore National Laboratory (LLNL). This program was initiated on July 1, 1983 and extended through September 30, 1985. This program was concerned with the development of RF systems to meet the objectives of the TMX-U mirror program at LLNL. To accomplish this the following areas were studied during the course of this contract: (1) Ion Cyclotron Heating, (2) Electron Cyclotron Heating, (3) Drift Pumping, (4) Plasma Modeling, (5) Neutral Beam Heating, and (6) Neutral Gas transport and fueling. The key results of these activities are reported.

33412 **Method to produce large, uniform hollow spherical shells.** Kendricks, C.D. (to Dept. of Energy). US Patent 4,548,767. 22 Oct 1985. Filed date 26 Sep 1983. vp.

PAT-APPL-535464.

Large, uniform hollow spherical shells are produced by forming uniform size drops of heat decomposable or vaporizable material, evaporating the drops to form dried particles, coating the dried particles with a layer of shell forming material, and heating the composite particles to melt the outer layer and decompose or vaporize the inner particle to form an expanding inner gas bubble which expands the outer layer. By cycling the temperature and pressure on the hollow shells, spherical shells with uniform walls are produced.

33413 **Improved brightness of the ATA injector.** Weir, J.T.; Caporaso, G.J.; Chambers, F.W.; Kalibjian, R.; Kallman, J.; Paul, A.C.; Prono, D.S.; Slominski, M.E. (Lawrence Livermore National Laboratory, University of California, Livermore, CA). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-32**: No. 5, 1812-1813(Oct 1985). (CONF-850504—).

From Particle accelerator conference; Vancouver, Canada (13 May 1985).

Studies of the ATA injector using the low density plasma cathode (flashboard cathode) have shown that the brightness of the injector was being limited by the non-uniform emission of the cathode surface. To avoid this difficulty, we rearranged the cathode-anode geometry to accommodate field shaping surfaces and a field emission cathode. Computer simulations of the cathode-anode geometry using the EBQ code led us to try a 5.5 cm radius cathode with an A-K gap of about 13 cm. There was no grid used during the experiment. The cathode was surrounded by a Pierce correcting shroud and the typical gap voltage was about 2.5 MeV. Our initial tests of the field emission cathodes were done using a woven carbon yarn that was laced through a fine mesh screen and then trimmed to a uniform height. Using these "tufted" cathodes, it was easy to vary the number of emission sites per square centimeter. We also varied the geometry of these cathodes by giving the screen a slight convex shape so that the center of the cathode was about 1 cm closer to the anode plane than the edge of the cathode. At the suggestion of R. Adler of MRC, we also tested commerically available velvet cloth. This was done by epoxying the cloth to the cathode surface using a conducting silver epoxy. We tested the velvet cathodes in both the flat and convex configurations to compare with the tufted carbon yarn cathodes.

33414 **Moderator detritiation at the Savannah River Plant.** Baumgarten, P.K.; Howard, D.W. (E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, SC). *Fusion Technology;* **8**: No. 2, 2491-2494(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

A study has been made of the technical and economic aspects of reducing tritium concentration in Savannah River Plant heavy-water moderator by 90%. A single detritiation plant would serve four operating reactors and the desired tritium reduction would be achieved in less than ten years. The process choice has narrowed to three processes. These involve a front-end extraction or preparation of molecular DT in a D_2 stream, and a back-end fractional distillation of this stream followed by catalytic conversion to make 98% tritium T_2.

33415 **Unresolved tritium issues in the Magnetic Fusion Energy Program.** Anderson, J.L.; Bartlit, J.R. (Materials Chemistry Group, Materials Science and Technology, Los Alamos National Laboratory, Los Alamos, NM). *Fusion Technology;* **8**: No. 2, 2027-2030(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

This paper discusses twelve issues involving tritium in the Magnetic Fusion Energy Program that remain to be resolved. The issues are discussed in three broad categories: fuel reprocessing issues, detritiation issues, and tritium handling issues. Where appropriate, suggestions are made concerning routes to resolution of the issues.

33416 **Experimental design to study tritium oxidation as a means of tritium control.** Finn, P.A.; Van Deventer, E.M. (Chemical Technology Division, Argonne National Laboratory, Argonne, IL). *Fusion Technology;* **8**: No. 2, 2438-2443(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

The design of an experiment for determining the kinetic rate of the tritium oxidation reaction when tritium atoms are present is described. Determination of the reaction rate will be done by analyzing the ratio of T_2 and T_2O product as a function of time, temperature, tritium concentration, and oxygen concentrations. A model of a proposed surface reaction is given.

33417 **Operating experience with the Sandia tritium facility cleanup systems.** Gildea, P. (Sandia National Laboratories, Livermore, CA). *Fusion Technology;* **8**: No. 2, 2505-2510(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

At Sandia Livermore, significant operating experience has been gained with the containment and cleanup systems that provide personnel safety and environmental protection in the tritium facility. The Gas Purification System (GPS) and Vacuum Effluent Recovery System (VERS)--used for cleanup of glove box and contaminated effluent, respectively--have been operating for more that 70,000 hours. Maintained at 811 K, the original catalyst has shown no indication of degraded performance. The dryer regeneration system has been used to recover 52,000 Ci, with no personnel uptake. Except for VERS vacuum pump overhaul, maintenance on both systems has been minimal.

33418 **Tertiary containment in a multi-room tritium facility.** Kent, L.R. (Monsanto Research Corporation, Mound, Miamisburg, OH). *Fusion Technology;* **8**: No. 2, 2511-2516(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

An experimental system to provide tertiary containment at Mound has been upgraded to support a new multi-room tritium handling facility. This system is used to remove tritium from room air in the event of primary (process) and secondary (glovebox) containment failure. The upgraded system includes a faster response time, piping and valves that are more leaktight, and a new control

panel that better indicates the system status and operating conditions.

33419 **Low concentration conversion of tritium gas to tritiated water.** Easterly, C.E.; Bennett, M.R.; Noguchi, H. (Oak Ridge National Laboratory, Oak Ridge, TN). *Fusion Technology;* 8: No. 2, 2564-2568(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Conversion rates of tritium gas (T_2) to tritiated water are reported for tritium in ambient air and in nitrogen mixtures for initial tritium concentrations between 10^{-3} and 1 Ci/m³. Evidence suggests that, for air mixtures, production of condensable species, primarily HTO, occurs at a rate commensurate with the tritium decay rate. Nitrogen with less than 0.05% oxygen decreases this rate by a small (about 25%) amount. Irradiation with up to 10 Krad ^{60}Co does not measurably affect the conversion rate in ambient air. This new data, along with the data from other authors, reveals that over the range of 10^{-3} to 10^{6} Ci/m³, there are three reaction order regimes: (1) first order between 10^{-3} and 10 Ci/m³, (2) approximately second order between 10 and 10^{4} Ci/m³, and (3) first order above 10^{4} Ci/m³.

33420 **Experiments on a ceramic electrolysis cell and a palladium diffuser at the Tritium Systems Test Assembly.** Konishi, S.; Binning, K.E.; Coffin, D.O.; Naruse, Y.; Ohno, H.; Walthers, C.R.; Yoshida, H. (Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki-ken). *Fusion Technology;* 8: No. 2, 2042-2047(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

A ceramic electrolysis cell and a palladium diffuser have been developed in Japan and tested with tritium at the Tritium Systems Test Assembly (TSTA) at the Los Alamos National Laboratory, to test their feasibility as possible upgrades for the fuel cleanup system (FCU). The ceramic electrolysis cell, made of stabilized zirconia, was operated at 630°C for an extended period with a mixture of 3% T_2O in He carrier gas in a circulation system with an oxidizing catalyst bed. The palladium diffuser was tested with pure tritium gas, circulated at 280°C, to verify the compatibility of the alloy with tritium, since the ^{3}He produced in the metal could cause degradation. The isotopic effects were also measured for both devices.

33421 **Release characteristics of tritium from high-purity lithium oxide.** O'Kula, K.R.; Vogelsang, W.F. (E. I. du Pont de Nemours & Company, Nuclear Engineering Division, Savannh River Laboratory, Aiken, SC). *Fusion Technology;* 8: No. 2, 2054-2060(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Rates of tritium release from neutronirradiated lithium oxide were determined from isothermal release experiments. High-purity, monocrystalline lithium oxide was purged ex-reactor with helium and helium-hydrogen gas streams. Overall release was found to be controlled by solid-phase diffusion, and was predominantly in the form of condensible species. The result of an independent concentration profile analysis at 923 K was in agreement with the gas release diffusion coefficient. Sweeping the Li_2O with hydrogen-containing gas was found to enhance tritium removal during the early stage of each run.

33422 **Modeling and experiments on tritium permeation in fusion reactor blankets.** Holland, D.F.; Longhurst, G.R. (EG & G Idaho, Inc., Idaho Falls, ID). *Fusion Technology;* 8: No. 2, 2067-2076(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Issues are discussed that are critical in determining tritium loss from helium-cooled fusion breeding blankets. These issues are: (a) applicability of present models to permeation at low tritium pressures, (b) effectiveness of oxide layers in reducing permeation, (c) effectiveness of hydrogen addition as a means to lower tritium permeation, and (d) effectiveness of conversion to tritiated water and subsequent trapping as a means to reduce permeation. The paper discusses theoretical models applicable to these issues, and presents results of experiments in two areas: permeation of mixtures of hydrogen isotopes and conversion to tritiated water.

33423 **A new tritium monitor for the Tokamak Fusion Test Reactor.** Jalbert, R.A. (Los Alamos National Laboratory, Los Alamos, NM). *Fusion Technology;* 8: No. 2, 2077-2081(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

At DT-fueled fusion reactors, there will be a need for tritium monitors that can simultaneously measure in real-time the concentrations of HTO, HT and the activated air produced by fusion neutrons. Such a monitor has been developed, tested and delivered to the Princeton Plasma Physics Laboratory for use at the Tokamak Fusion Test Reactor (TFTR). It uses semipermeable membranes to achieve the removal of HTO from the sampled air for monitoring and a catalyst to convert the HT to HTO, also for removal and monitoring. The remaining air, devoid of tritium, is routed to a third detector for monitoring the activated air. The sensitivities are those that would be expected from tritium instruments employing conventional flow-through ionization chambers: 1-3 $\mu Ci/m^3$. Its discriminating ability is approximately 10^{-3} for any of the three components (HTO, HT and activated air) in any of the other two channels. For instance, the concentration of HT in the HTO channel is 10^{-3} times its original concentration in the sampled air. This will meet the needs of TFTR.

33424 **Development of an integrated monitoring system for a new tritium facility at Mound.** Rhinehammer, T.B.; Burgess, T.E.; Spyrow, E.L. (Monsanto Research Corporation, Mound, Miamisburg, OH). *Fusion Technology;* 8: No. 2, 2095-2102(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

A stand-alone system was developed for monitoring process support services and tritium levels in gloveboxes, room air, room exhaust ducts, and stack exhaust. Sixty tritium monitors were built and interfaced to a Health Physics control room where all tritium levels are displayed and abnormal conditions appear as alarms on large display boards. The control room was designed for full remote control of all monitors, with the exception of those for gloveboxes, as well as for control and alarm display of many other functions, including the purge rate for glovebox atmosphere and the selection of room air discharge to stack or to a tritium cleanup system. The monitoring system is interfaced to a date gathering computer and an automatic dialing alarm system.

33425 **Use of metal hydrides for handling tritium.** Ortman, M.S.; Smith, D.J.; Warren, T.J. (E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, SC). *Fusion Technology;* 8: No. 2, 2330-2336(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Savannah River Laboratory is developing new technology to improve the safety, reliability, and flexibility of processing tritium at the Savannah River Plant. This technology, based on metal hydrides, will also decrease the equipment size. The LaNi /sub 5-x/ Al /sub x/ series of alloys is used for tritium storage applications and palladium coated on kieselguhr is used for pumping. In using metal hydrides to handle tritium, special considerations do exist and they must be understood, but they are not causes for concern.

33426 **Long-term behavior of the tritides formed by nickel-based intermetallic compounds.** Bowman, R.C.; Attalla, A.; Craft, B.D.; Matson, L.K.; Steinmeyer, R.H. (Monsanto Research Corporation, Mound Miamisburg, OH). *Fusion Technology;* 8: No. 2, 2337-2343(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Some properties of the tritide phases formed by the intermetallic compounds Mg_2Ni, ZrNi, and $LaNi_5$ have been studied. Whereas $ZrNiT_3$ will retain its stoichiometry indefinitely when sufficient gaseous tritium is available, the stoichiometries of Mg_2NiT_4 and $LaNi_5T$ /sub 6.9/ decrease with time. Although all three intermetallic tritides can retain large quantities of the helium-3 tritium decay daughter product in the solid phase, irreversible release of helium begins after several hundred days for ZrNiT /sub x/ and Mg_2NiT /sub x/. However, $LaNi_5T$ /sub x/ retains all of the helium generated in the solid for at least 2400 days. NMR measurements for ZrNiT /sub x/ and Mg_2NiT /sub x/ imply that helium is retained in microscopic bubbles as previously observed in several binary metal tritides.

33427 **Some tips on tritium technology.** Anderson, J.L.; Coffin, D.O.; Jalbert, R.A.; Nasise, J.E.; Sherman, R.H. (Los Alamos National Laboratory, Los Alamos, NM). *Fusion Technology;* 8: No. 2, 2413-2419(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

This collection of practical suggestions should prove useful to workers at tritium installations where gloveboxes and cleanup systems are used, or where upgrades to such systems are anticipated. These tips are effective approaches to meeting today's stringent containment requirements, and include many applications and extensions of accepted tritium practice, plus a few innovations of our own. The subjects covered are tritium piping systion, tritium monitoring, and contamination control. Some specific problems arising out of recent experience are also discussed, along with some tentative solutions.

33428 **Cost of processing fuel from a molten salt, fusion/fission, hybrid reactor blanket.** Watson, J.S.; Brashears, D.E.; Grimes, W.R. (Oak Ridge National Laboratory, Oak Ridge, TN). *Fusion Technology;* 8: No. 2, 2113-2120(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

A conceptual flowsheet was prepared for continuous processing of molten salt used as the blanket material for breeding tritium and fissile material (^{233}U) in a fusion/fission hybrid reactor. The salt, which has a melting point of about 530°C, was 70 mol % LiF, 12 mol % BeF_2, and 18 mol % ThF_4. The hybrid reactor generates 3000 MWe, and the blanket contains 65 m^3 of the breeding salt.

33429 **Tritium control in helium-cooled blankets.** Wong, C.P.C.; Kessel, C.; Maya, I.; Roelant, D.; Schultz, K.R. (GA Technologies Inc., San Diego, CA). *Fusion Technology;* 8: No. 2, 2133-2142(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

As a part of the Blanket Comparison and Selection Study (BCSS), GA Technologies was responsible for the design of helium-cooled, solidand liquid-metal breeder blankets. Conceptual blanket designs were developed, including the consideration of the generation, transport, and extraction of tritium. Evaluations were made of the inventory and leakage of tritium for helium-cooled Li_2O and $LiA10_2$ and liquid lithium breeder blankets for tokamak and tandem mirror reactors. To facilitate the evaluation, a solid breeder tritium code TRIT4 was developed.

33430 **Cryogenic hydrogen isotope distillation for the fusion fuel cycle.** Sherman, R.H. (Materials Chemistry Group, Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, NM). *Fusion Technology;* 8: No. 2, 2175-2183(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Cryogenic distillation is an attractive method for the hydrogen isotopic separations required in fusion fuel cycles. The theoretical and practical aspects of designing and constructing such systems are well established. Practical considerations in the design of systems are presented and applied to the Isotope Separation System (ISS) at the Tritium Systems Test Assembly (TSTA), as well as systems of distillation columns that might be used for a reactor such as the Tokamak fusion Core Experiment (TFCX) and the recovery of breeding blanket product.

33431 **A low temperature distillation system for separating mixtures of protium, deuterium, and tritium isotopes.** Embury, M.C.; Hinckley, R.; Post, A.H.; Watkins, R.A. (Monsanto Research Corporation, Mound, Miamisburg, OH). *Fusion Technology;* 8: No. 2, 2168-2174(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

A low temperature (24 K) distillation system for separating mixtures of hydrogen isotopes has been designed, fabricated, and delivered for use as the main component of the Hydrogen Isotope Separation System (HISS) at Mound. The HISS will handle feed mixtures of all six isotopic species of hydrogen (H_2, HD, HT, D_2, DT, T_2) and will enrich the tritium while producing a stackable raffinate. The design and fabrication techniques used for the HISS distillation system are similar to those used for previous stills. The distillation system was tested with mixtures of protium and deuterium. This system, as well as the feed, product, and raffinate handling systems are presently being installed at Mound where integrated testing is scheduled next calendar year.

33432 **Early operating experience with the Tritium Systems Test Assembly tritium waste treatment system.** Carlson, R.V.; Cole, S.P. (Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, NM). *Fusion Technology;* 8: No. 2, 2184-2189(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

At the Tritium Systems Test Assembly, tritium is removed from all gaseous waste before these gases are released to the environment. The removal is based on the catalytic conversion of tritium gas and tritiated compounds to the water form and collection of the tritiated water on molecular sieve. The system has operated reliably during the initial tritium phases of TSTA operation with no major problems.

33433 **Operation of the room air tritium removal system at the Tritium Systems Test Assembly.** Carlson, R.V.; Binning, K.E.; Damiano, F.A. (Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, NM). *Fusion Technology;* 8: No. 2, 2190-2195(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Fusion reactor facilities will be required to minimize releases of hazardous materials to the environment during both normal operations and accident situations. The Tritium Systems Test Assembly (TSTA) at the Los Alamos National Laboratory has a tritium removal system, capable of processing room air to collect tritium accidentally released into the tritium handling areas of the facility. This system, the Emergency Tritium Cleanup (ETC) system, will both minimize accidental releases to the environment from TSTA and demonstrate the feasibility and operations of a large room air detritiation system. The system is also designed to study tritium releases under controlled conditions. Based on the initial nontritium tests described in this paper, we have determined that the ETC has a single-pass efficiency for tritium collection of greater than 99.9%.

33434 Ultraviolet radiation-damage absorption line in solid deuterium-tritium. Fearon, E.M.; Hunt, J.L.; Poll, J.D.; Souers, P.C.; Tsugawa, R.T. (Lawrence Livermore National Laboratory, Livermore, CA). *Fusion Technology;* 8: No. 2, 2239-2244(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

An ultraviolet absorption feature has been seen in solid deuterium-tritium and hydrogen-tritium at a sensor temperature of 5 K. The peak occurs at 3.6 eV and is about 1.5 eV wide. It disappears when the temperature is raised to about 10 K but reappears upon cooling and is, therefore, radiation induced. At 5 K, the absorption line forms on a time scale of minutes and appears to represent part-per-million levels of electron-mass defects. The suggested model is that of a trapped electron, where the absorption line is the ground state-to-the-conduction band transition. A marked isotope effect is seen between D-T and H-T.

33435 Separation of hydrogen isotopes by thermal diffusion. Rutherford, W.M.; Lindsay, C.N. (Monsanto Research Corporation, Mound, Miamisburg, OH). *Fusion Technology;* 8: No. 2, 2278-2284(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

At high hot wall temperatures the gas phase thermal diffusion column acts as an atomic rather than a molecular separator. A modified theory was developed to describe the process. Equivalent transport equations were derived for the two nuclides in a binary atomic mixture. The equations are identical in form to those normally encountered in thermal diffusion column theory. Experiments to test the theory were carried out with two 3-meter columns. Experimental results with deuterium-tritium mixtures were found to be in satisfactory agreement with theory, and it was concluded that the theory was sufficiently accurate for design purposes.

33436 Tritium-helium effects in metals. Caskey, G.R. (Savannah River Laboratory, Aiken, SC). *Fusion Technology;* 8: No. 2, 2293-2298(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Investigations of helium effects in metals at the Savannah River Laboratory have been carried out by introducing helium by radioactive decay of tritium. This process does not create concurrent radiation damage, such as accompanies ion implantation and (n,α) reactions. The process has its own peculiarities, however, which partially mask and interact with the helium effect of interest. The distribution and local concentration of helium and tritium, which are responsible for changes in mechanical properties and fracture mode, are controlled by the large difference in solubility and diffusivity between the two atoms and by their differing interaction energies with lattice defects, impurities, and internal boundaries. Furthermore, in all investigations with helium generated from tritium decay, some tritium and deuterium are always present. Consequently, property changes include tritium-helium interaction effects to some extent. Results of investigations with several austenitic stainless steels, Armco iron, and niobium single crystals illustrate the variety of phenomena and some of the complex interactions that can be encountered.

33437 Permeation of deuterium implanted into fusion reactor materials. Andrel, R.A.; Holland, D.F.; Longhurst, R.A.; Struttman, D.A. (EG & G Idaho Inc., Physical and Biological Sciences Div., Idaho Falls, ID). *Fusion Technology;* 8: No. 2, 2299-2305(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

This paper reports on implantation-driven permeation experiments made for primary candidate alloy (PCA) and the ferritic steel HT-9 using deuterium ion beams from an accelerator. The results include measurements of the implantation flux and fluence dependence of the deuterium reemission and permeation for specimens heated to approximately 430°C. Simultaneous measurements of the ions sputtered from the specimen front surface with a secondary ion mass spectrometer provided some characterization of the surface condition throughout an experiment. For both materials, the permeation rate was lowered by the implantation process. However, the steady state permeation rate for HT-9 was found to be at least a factor of 5 greater than that for PCA.

33438 Interaction of polyethylene and tritium gas as monitored by raman spectroscopy. Gill, J.T. (Monsanto Research Corporation - Mound, Miamisburg, OH). *Fusion Technology;* 8: No. 2, 2318-2329(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

Irradiation of high-density polyethylene by an $\int 1$ atm overpressure of T_2 gas at 23 + or - 2°C has been shown to produce severe damage, $\int 200$ MRad dose, within 6 months. Production rate of H_2 gas from irradiation due to polymer incorporation of tritium increased quickly within the first 2 months, after which it slowed considerably. It is proposed that outgassing of H_2 acted to inhibit diffusion of solubilized HT or T_2 into the bulk, thereby limiting increases in polymer T incorporation and thus damage rate. Damage to the HDPE sample was found to be nonuniform. Laser fluorescence from the sample surface irradiated by the supply of T_2 gas was $\int 10^3$-fold greater in the energy deposition layer than the fluorescence from bulk polymer after 2 months. This factor was within an order of magnitude of calculated dosages to surface and bulk. Fluorescence from the bulk, apparently caused by unsaturated polyene groups formed during irradiation, grew in time about proportionally to H_2 generation and thus dose. An appreciable concentration of radical or ion-radical polyenes at room temperature could be recombined by bleaching for 15 minutes at $\int 150$°C; these species appeared to reform over night at room temperature.

33439 A novel technique for measurement of tritium permeation through resistant materials near room temperature: demonstration of method with copper at 50-170°C. Maienschein, J.; Du Val, V.; McMurphy, F.; Uribe, F. (Lawrence Livermore National Laboratory, Livermore, CA). *Fusion Technology;* 8: No. 2, 2360-2365(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

To measure tritium permeation through low-permeability materials at 50-170°C, we use highly-sensitive liquid scintillation counting to detect the permeating tritium. To validate our method, we conducted extensive experiments with copper, for which much data exists for comparison. We report permeability of tritium through copper at 50, 100, and 170°C, and discuss details of the experimental technique. Further plans are outlined.

33440 Isotope effects and helium retention behavior in vanadium tritide. Bowman, R.C.; Attalla, A.; Craft, B.D. (Monsanto Research Corporation, Mound, Miamisburg, OH). *Fusion Technology;* 8: No. 2, 2366-2372(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

The relaxation times of the M, T, and ^{3}He nuclei have been measured in vanadium hydride and tritide samples. Substantial isotope effects in both the phase transition temperatures and diffusion parameters have been found. When compared to hydrides, the tritide samples have lower transition temperatures and faster mobilities. The differences in the occupancies of the interstitial sites are largely responsible for these isotope effects. Most of the helium atoms generated by tritium decay remain trapped in microscopic bubbles formed within the VT /sub x/ lattice. Evidence is presented for the gradual growth of the helium bubbles over periods of hundreds of days.

33441 Diffusion and solubility of tritium in Path A Prime Candidate Alloy. Causey, R.A.; Steck, L.M.; Van Namen, R. (Sandia National Laboratory, Livermore, CA). *Fusion Technology;* 8: No. 2, 2384-2387(Sep 1985). (CONF-850405—).

From 2. national topical meeting on tritium technology in fission, fusion and isotopic applications; Dayton, OH, USA (30 Apr 1985).

The tritium recoil injection technique was used to determine the tritium diffusion coefficient for Path A Prime Candidate Alloy (PCA) over the temperature range 323K to 523K. Dissolution tritium counting of samples saturated in a tritium-hydrogen mixture was used to determine the tritium solubility for PCA over the temperature range 673K to 973K. No evidence of high energy trapping due to the titanium carbide precipitates in PCA was seen.

33442 **ICRF technology development on the Princeton RF Test Facility.** Fortgang, C.M.; Hwang, D.Q. (McDonnell Douglas Corporation). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 61-64(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Dielectric filled rigid waveguide is being considered as a possible ICRF launcher for an ignition device.

33443 **ICRF antenna and feedthrough development at the Oak Ridge National Laboratory.** Owens, T.L.; Baity, F.W.; Hoffman, D.J. (Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 95-98(Jul 1985). (CONF-8505130—). Contract AC05-84OR21400.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Antennas, vacuum feedthroughs, Faraday shields, and antenna materials for application in the ICR frequencies have been analysed and tested. The emphasis on the RDL (resonant double loop) antenna.

33444 **Heating, current drive and transport properties of large area ICRF couplers.** Taylor, R.J.; Brown, M.; Evans, J.D.; Lai, K.F.; Rossing, V. (Center for Plasma Physics and Fusion Engineering, University of California at Los Angeles, California 90024). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 107-110(Jul 1985). (CONF-8505130—). Contract AM03-76SF00010.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

Initially, the large area ICRF couplers were studied in Macrotor in order to minimize the effects of the RF on the edge plasma and on the related transport. Recently, the following three aspects of these couplers have been studied. (1) Reduction of the edge power density by size alone. (2) Formation of a narrow K-parallel spectrum. (3) The utilization of this powerful technique for fast wave lower hybrid current drive generation. Current drive experiments in Macrotor have resulted in the prediction that a continuously driven tokamak operation can be achieved at a level that will be consistent with neo-Alcator scaling.

33445 **Arc inhibitors for lower hybrid waveguide arrays.** Motley, R.W.; Greene, G.J. (Plasma Physics Laboratory, Princeton University). *AIP (American Institute of Physics) Conference Proceedings;* **129**: No. 1, 170-173(Jul 1985). (CONF-8505130—). Contract AC02-76CH03073.

From 6. topical conference on radio frequency plasma heating; Pine Mountain, GA, USA (13 May 1985).

The discontinuity at the mouth of a phased array between waveguide fields and plasma fields gives rise to strong, localized electric fields at the septa, especially if the array is excited asymetrically. Methods are suggested for modifying these fields to reduce the possibility of arcing. Probe measurements of the fields near the septa show that small but significant reductions of the local fields are possible and might raise the maximum power handling capability of an array.

33446 **Comparison of pulsed and steady-state tokamak reactor burn cycles. Pt. 1. Thermal effects and lifetime limitations.** Ehst, D.A.; Cha, Y.; Hassanein, A.M.; Majumdar, S.; Misra, B.; Stevens, H.C. (Argonne National Lab., IL, USA. Fusion Power Program). *Nuclear Engineering and Design/Fusion;* **2**: No. 4, 305-318(Jul 1985).

Four distinct operating modes have been proposed for tokamaks, and consequently a variety of thermal environments can be postulated for future reactor subsystems. Our study concentrates on lifetime limitations associated with fluctuating thermal loads on the first wall, limiter or divertor plates, and in the breeding blanket. Simultaneous failure from thermal fatigue, radiation damage, and disruption-induced erosion is considered, and burn length goals are calculated in order to help achieve high availability for a commercial reactor. In addition, the cost of thermal storage is found as a function of the dwell period between burns of a pulsed cycle; thermal storage is shown to be an expensive requirement for pulsed reactors. (orig.).

33447 **Upgrade of MFTF-B for fusion technology.** Thomassen, K.I.; Doggett, J.N.; Logan, B.G.; Nelson, W.D. (Lawrence Livermore National Lab., CA, USA; Oak Ridge National Lab., TN, USA. Fusion Engineering Design Center). *Nuclear Engineering and Design/Fusion;* **2**: No. 3, 209-222(Mar 1985). Contract W-7405-ENG-48.

A deuterium-tritium (DT) burning upgrade to the MFTF-B tandem mirror that incorporates a high neutron flux test section in the central cell is described. This test section is a beam-driven simple mirror, where 11 MW of fusion power produces a neutron flux of proportional 2 MW/m². In this test section one can perform 100 h uninterrupted tests of the power and fuel cycle operation of fusion blankets. The tandem mirror in which this section is embedded in a scale down version of the MARS reactor. It uses 200 kV negative ion beams, an 18 T choke coil, drift pumping for removing α-ash and ions trapped in the barrier/transition, halo pumping, and biased end plates for potential control and direct conversion. There are two modes of operation in the device: one mode achieves the high neutron flux by injecting beams in the test section and reducing the end plug potential to accomodate the high throughput of particles; the other mode reduces the beam input to the minimum required for fueling and raises the end potentials to their highest possible values for good confinement. This two-mode operation is a unique feature of the tandem that allows a dual physics-nuclear technology role for the device. (orig.).

33448 **Fusion technology demonstration facility (TDF).** Doggett, J.N.; Logan, B.G.; Osher, J.E.; Thomassen, K.I.; Nelson, W.D. (Lawrence Livermore National Lab., CA, USA; Oak Ridge National Lab., TN, USA. Fusion Engineering Design Center). *Nuclear Engineering and Design/Fusion;* **2**: No. 3, 223-237(Mar 1985). Contract W-7405-ENG-48.

This paper describes a facility for generating engineering data on the nuclear technologies needed to build an engineering test reactor (ETR). The facility, based on a tandem mirror operating in the Kelley mode, could be used to produce a high neutron flux (1.4 MW/m²) on an 8 m² test area for testing fusion blankets. Runs of more than 100 hours, with an average availability of 30%, would produce a fluence of 5 MW.yr/m² and give the necessary experience for successful operation of an ETR. (orig.).

33449 **The integrated-blanket-coil concept applied to the poloidal field and blanket systems of a tokamak reactor.** Steiner, D.; Block, R.C.; Malaviya, B.K. (Rensselaer Polytechnic Institute, Department of Nuclear Engineering, Troy, NY). *Fusion Technology;* **7**: No. 1, 66-77(Jan 1985).

A novel concept is proposed for combining the blanket and coil functions of a fusion reactor into a single component. This concept, designated the "integrated-blanket-coil" (IBC) concept, is applied to the poloidal field and blanket systems of a tokamak reactor. An examination of resistive power losses in the IBC suggests that these losses can be limited to 10% of the fusion thermal power. By assuming a sandwich construction for the IBC walls, magnetohydrodynamic (MHD)-induced pressure drops and associated pressure stresses are shown to be modest and well below design limits. For the stainless steel reference case examined, the MHD-induced pressure drop was estimated to be about 1/3 MPa and the associated primary membrane stress was estimated to be about 47 MPa. The preliminary analyses indicate that the IBC concept offers promise as a means for making fusion reactors more compact by combining blanket and coil functions in a single component.

33450 **Subcooled flow boiling critical heat flux (CHF) and its application to fusion energy components. Part I. A review of fundamentals of CHF and related data base.** Boyd, R.D. (Sandia National Laboratories, Albuquerque, NM). *Fusion Technology;* 7: No. 1, 7-30(Jan 1985).

The present understanding of critical heat flux (CHF) in subcooled flow boiling with water is reviewed and fusion reactor component high-heat flux (HHF) requirements are outlined. This survey (Parts I and II), which contains a representative coverage of the literature over the last 30 years, is concerned only with CHF in the subcooled flow boiling regime. CHF data base parameter ranges are also given as an aid for fusion component designers in locating the appropriate data for an application. Because of the relatively HHF levels and long pulse durations in the next generation reactors, fusion components must be actively cooled. All fusion components are heated nonuniformly over their surface and their surface area ranges from 0.1 to 1000 m^2. Although most components are subjected to fluxes from about 0.005 kW/cm^2 (first wall) to near 1 kW/cm^2 (limiters and divertors), some components are subjected to fluxes from 2 kW/cm^2 (first wall in compact reactors) to 8 kW/cm^2 (beam dumps). Subcooled flow boiling has the greatest potential of accommodating the steady-state HHF levels encountered by fusion reactor components. Although the available heat flux data base brackets those for most fusion components, the existing data are sparse or nonexistent for the length-to-diameter ratios (e.g., >200 for limiters and >50 for beam dumps) necessary for future HHF fusion components. There are more than 20 parameters that influence subcooled flow boiling CHF and many other tested techniques that enhance heat transfer by a factor of >2. The engineering implementation and design of fusion components cannot be optimized until the physical relationships between the maximum CHF and both the flow parameters and thermophysical properties have been determined. This can be accomplished only if improvements are made in the understanding of the fundamental mechanisms controlling the heat transfer and CHF in the subcooled flow boiling regime.

33451 **Subcooled flow boiling critical heat flux (CHF) and its application to fusion energy components. Part II. A review of microconvective, experimental, and correlational aspects.** Boyd, R.D. (Sandia National Laboratories, Albuquerque, NM). *Fusion Technology;* 7: No. 1, 31-52(Jan 1985).

Microconvective, instability, experimental, and correlational aspects of subcooled flow boiling critical heat flux (CHF) are summarized. The present understanding of CHF in subcooled flow boiling is reviewed and research directions that will permit the accommodation of higher heat fluxes are outlined. This survey (Parts I and II), which contains a representative coverage of the literature over the last 30 years, is concerned only with CHF in the subcooled flow boiling regime, and unless otherwise noted, all references to CHF are confined to that regime.

33452 **Thermal analysis of the Tokamak Fusion Test Reactor vacuum vessel.** Fixler, S.Z.; Bialek, J.; Gilchrist, G.W. (Grumman Aerospace Corporation, Bethpage, NY). *Fusion Technology;* 7: No. 1, 111-124(Jan 1985).

A transient thermal analysis was conducted on the Tokamak Fusion Test Reactor vacuum vessel to determine the response of the vessel and its critical components to several pulsed discharge cleaning (PDC) and in situ bakeout scenarios. The three-dimensional model is described. The method of analysis, flow distribution, boundary conditions, and assumed configuration are stated. The resultant temperatures and thermal gradients are presented as a function of time and space on the vessel, bellows, bellows covers, ports, and port covers. Two PDC and three bakeout scenarios were analyzed. For nominal discharge cleaning, a 100-kW plasma with a 25-kW bellows ohmic heat (OH) dissipation was assumed. For aggressive discharge cleaning, a 400-kW plasma with a 100-kW bellows OH dissipation was assumed. In the first bakeout scenario a series of 56°C (100°F) temperature steps (ΔT) was imparted to the heating air at 10-h intervals until a bakeout temperature of 250°C was attained. In the second scenario the interval between steps was increased to 25 h. In the third scenario the temperature step (ΔT) was reduced to 28°C (50°F) at 10-h intervals between steps. The results of the analysis indicate that temperatures during initial operations can be maintained within allowable limits. A PDC maximum temperature of 232°C occurs on the bellows cover plates. The bakeout results show that for a 28°C step, 10-h interval, it takes 112 h to bake out the entire torus. Initial results of the thermal analysis enabled setting up in situ bakeout constraints that prevent excessive vessel/bellows stresses and minimized bakeout run times.

33453 **A 1-D hybrid code for FRM dynamics.** Stark, R.A.; Miley, G.H. (Naval Surface Weapons Center, Silver Springs, MD). pp 759-769 of Proceedings of an international meeting on advances in nuclear engineering computational methods. Volume 2. LaGrange Park, IL; American Nuclear Society (1985). (CONF-850411—).

From International meeting on advances in nuclear engineering computational methods; Knoxville, TN, USA (9 Apr 1985).

A 1-D radial hybrid code has been written to study the start-up of the FRM via neutral-beam injection. This code, named FROST (Field Reversed One-dimensional STart-up), models the plasma as azimuthal symmetric with no axial dependence. A multigroup method in energy and canonical angular momentum describes the large-orbit ions from the beam. This method is designed to be more efficient than those employing particle tracking, since the characteristic timescale of the simulation is the ion slowing down time, rather than the much shorter cyclotron period. A time-differentiated Grad-Shafranov equation couples the ion current to massless fluid equations describing electrons and low energy ions. Flux coordinates are used in this fluid model, in preference to an Eulerian framework, so that coupling of plasma at the two different radii of a closed flux surface may be treated with ease. Since a fluid treatment for electrons is invalid near a field null, a separate model for the electron current has been included for this region, a unique feature. Results of simulation of injection into a 2XIIB-like plasma is discussed. Electron currents are found to retard, but not prevent reversal of the magnetic field at the plasma center.

33454 **Negative ion beam requirements for compact tori.** Miley, G.H. (Fusion Studies Laboratory, University of Illinois, 103 S. Goodwin Ave., Urbana, Illinois 61801). *AIP (American Institute of Physics) Conference Proceedings;* **111**: No. 1, 647-658(1 Mar 1984). (CONF-831180—). Contract AC02-76ET52040.

From 3. international symposium on the production and neutralization of negative ions and beams; Upton, NY, USA (14 Nov 1983).

One potential application of negative ion beam sources involves injection into field-reversed fusion devices for both start-up and sustainment of plasma currents. High energies provide the prerequisite large orbit ions to drive these currents. A hybrid fluid-particle computational model is described that has been developed to study injection into a field-reversed mirror. Comparisons with the earlier experiments (2X-IIB) at the Lawrence Livermore National Laboratory are encouraging and support the concept of using high-energy injection in future devices.

33455 **Heavy-ion radiative capture.** Sandorfi, A.M. (Brookhaven National Lab., Upton, NY). pp 53-111 of Treatise on heavy-ion science. Vol. 2: fusion and quasi-fusion phenomena. Bromley, D.A. New York, NY; Plenum Press (1984).

This chapter discusses high-energy gamma decays to bound states and examines techniques for studying fusion followed by high-energy y decay. The experimental geometry used in the electrofission-coincidence experiments is shown. Fusion/fission resonances in Mg-24 and Si-28 are discussed, then compared with other reactions. A statistical model analysis of Mg-24 resonances is presented and the radiative capture in other heavy-ion systems is reviewed. Ultrasensitive particle identification systems are discussed which use an electrostatic accelerator as one element to detect nuclei with sensitivities as high as 1 part in 10^{15}.

33456 **New poloidal and toroidal crowbar systems in ETA-BETA II.** Piovan, R.; Guarnieri, M. (Istituto Gas Ionizzati del CNR, Associazione EURATOM-CNR, Padova). pp 1648 of Fusion engineering. Vol. 2. New York, NY; IEEE (1983). (CONF-831203—).

From 10. symposium on fusion engineering; Philadelphia, PA, USA (5 Dec 1983).

A new power crowbar system has been recently assembled in Eta-Beta II, both in the poloidal and in the toroidal circuits, in order to sustain and extend as long as possible the plasma pulse and to achieve an effective flat-top phase. Starting from plasma physical specifications, a crowbar system made with capacitor banks in a direct parallel connection for both circuits has been chosen since they were considered the most suitable in the concerned range of power and energy. Both systems include an original protection system of the main capacitor bank against casual or systematic dangerous currents and voltages. This protection system required a careful optimization of many involved component as capacitors, inductances and diodes. The main steps in the design of the systems is described and emphasis is given to the analysis of original problems which were solved, such as direct parallel connection of more ignitron series. Finally the tests performed on the circuits and components are presented and the performances of the systems are shown and discussed.

99 GENERAL AND MISCELLANEOUS

33457 (DOE/BC/10439—T1) Summer Research Apprentice Program report. Curington, B. (Northeastern Oklahoma State Univ., Tahlequah (USA)). 1982. Contract FG19-81BC10439. 5p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010598.

The Summer Research Apprentice Program is designed to provide students with their first look at college life while preparing them for possible careers in mathematics, science and engineering. The 23 students, enrolled as college freshmen for 8 hours of college credit, took courses in Trigonometry, College Algebra and introduction to Research (4 students were enrolled in Calculus 1 instead of Trigonometry and College Albebra). During this third year of operation, refinements were made in both the administration of the program and in the method of implementation.

33458 (ORNL/TM—9904) Protection of spacecraft from meteoroids and orbital debris. Fraas, A.P. (Oak Ridge National Lab., TN (USA)). Mar 1986. Contract AC05-84OR21400. 66p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86009996.

This report presents a review of information on the incidence of meteoroids and solid debris in orbital space, the damaging effects of these materials, and the principles that may be used to design protective shields for orbiting spacecraft. The report was prepared as part of a current Oak Ridge National Laboratory effort to develop and evaluate conceptual designs of space power systems.

33459 (UCID—20735) Appropriate MAWP static gas load for launching grenades from the M-16, A-1 rifle. Morgan, B. (Lawrence Livermore National Lab., CA (USA)). 12 Mar 1986. Contract W-7405-ENG-48. 17p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010260.

Launching small grenades from the muzzle of a service rifle constitutes an abnormal use of standard propellants used in loading ammunition. An analysis of system strength capabilities, types and characteristics of mechanical loading, appropriate safety factors and the energy producing characteristics of various propellant types is needed to better understand how this might be done safely. Then specific propellant loading recommendations are made based on these findings.

33460 (UCRL—94404) Calendars in IFPS/personal. Mode, V.A. (Lawrence Livermore National Lab., CA (USA)). 9 Apr 1986. Contract W-7405-ENG-48. 11p. (CONF-8606110—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86009602.

From IFPS Users Association meeting; San Francisco, CA, USA (9 Jun 1986).

The use of the Julian period allows the simple calculation of linear calendar dates and date intervals. It has been possible to write simple Gregorian-Julian and Julian-Gregorian calendar algorithms for use with IFPS/Personal. The ability to make a direct date calculation in a single expression, without reference to tables or other functions, is a significant improvement over other techniques published previously.

9901 Management

33461 (AD-A—164146/3/XAB) USS Pueblo incident, warning cycle. Master's thesis. Koebke, K.D. (Defense Intelligence Coll., Washington, DC (USA)). 10 Sep 1984. 161p. NTIS, PC A08/MF A01.

The basic method used in the study was a historical examination of the Warning cycle and a quantitative evaluation of three portions of the cycle, i.e., risk assessment, the actual warning, and the communications. Risk assessment was defined so that it met the Joint Chiefs of Staff (JCS) criteria standard and was informative to all units up the chain of command with a single point of contact. The warning portion of the cycle was defined in terms of a single point of contact and its responsiveness to the system. Communications effectiveness was assessed using a 10 minute criteria for a net to be responsive to a Critic/Pinnacle message. The procedures that were actually used during the crisis were compared to the standards set by the definitions.

33462 (LA—10651) Symphony Time Accounting Resource (STAR). Newfield, S.E.; Booth, J.W.; Redman, D.L. (Los Alamos National Lab., NM (USA)). May 1986. Contract W-7405-ENG-36. 9p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86008028.

The Symphony Time Accounting Resource, a new time accounting system, that can be run on personal computers instead of computer mainframes is described. This new system is useful for organizations that do work under several job order numbers and/or accounting codes and could also be adapted for use by organizations on the recharge system. 1 fig., 2 tabs.

9902 Mathematics And Computers

REFER ALSO TO CITATION(S) 32431, 33264, 33462

33463 (BARC—1274) PLOT 3D: a multipurpose, interactive program for plotting three dimensional graphs. Jayaswal, B. (Bhabha Atomic Research Centre, Bombay (India)). 1985. 56p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86702101.

PLOT3D is a general purpose, interactive, three dimensional display and plotter program. Written in Fortran-77, it uses a two dimensional plotter software (PLOT-10) to draw orthographic axonometric projection of three dimensional graph comprising of smooth surface or cubical histogram, in any desired orientation, magnification and window, employing throughout highly accurate hidden lines removal techniques. The figure, so generated, can optionally be clipped, smoothened by interpolation, or shaded selectively to distinguish among its different faces. The program accepts data from an external file, or generates them through built-in functions. It can be used for graphical representation of data such as neutron flux, theta(x,y) in form of smooth surface, even if available data are very few in number. It is also capable of drawing histograms of quantities such as fuel power in a reactor lattice. Listing of the program is given.

33464 (CEA-N—2446) Numeric experiments on the Cray X-MP/48. Chauvet, Y.; David, J.; Meurant, G. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Jun 1985. 58p. (In French). NTIS (US Sales Only), PC A04/MF A01. File Number DE86751823.

In this paper, evaluation tests for the CRAY X-MP/48 are presented. We use parallel algorithms for solving the transport equation with Monte-Carlo and the conjugate gradient method for solving linear systems.

33465 (CONF-860678—1) Formal verification of properties of digital systems using an automated reasoning system. Kljaich, J.; Wojcik, A.S.; Smith, B.T. (Argonne National Lab., IL (USA); Michigan State Univ., East Lansing (USA). Dept. of Computer Science). 1986. Contract W-31-109-ENG-38. 15p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86005552.

From Design automation conference; Las Vegas, NV, USA (29 Jun 1986).

This paper describes a part of an ongoing research project whose goal is to develop a formal design verification system based on the use of ITP, an LMA (Logic Machine Architecture) based Interactive Theorem Prover developed at Argonne National Laboratory. Specifically, a Petri net representation for systems is described together with the ITP implementation of a rule-based system for the manipulation of system descriptions. To illustrate the representation and the capabilities of the system under development, the Draper Laboratories Fault-Tolerant Processor is used as an example. Results concerning the formal verification of the fault-tolerant properties of this system are described. 17 refs., 7 figs.

33466 (DOE/AL/26034—T4) Study for establishment of the Rio Grande Communications Network connecting federal, state and private facilities in New Mexico. (New Mexico Technet, Inc., Albuquerque (USA)). 30 Apr 1986. Contract FG04-84AL26034. 14p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010334.

A computer network which provides interconnections to Los Alamos National Laboratory, the New Mexico State Government Data and Communications Center in Santa Fe, the Albuquerque Operations Office of the Department of Energy, and New Mexico State University is described. The goals of the network are to facilitate technology transfer from the federal laboratories to the university community and the private sector and to attract new businesses or assist in the expansion of existing businesses to broaden the state tax base. Future plans call for new connections to the University of New Mexico and Sandia National Laboratory. Initial service offerings of the network are electronic mail, communications, bulletin board, financial/statistical data modeling, and external data base access. The financial status of the network is also presented. (DWL)

33467 (EGG-M—26585) Comments on achievable eigenvectors. Griffith, J. (Idaho National Engineering Lab., Idaho Falls (USA)). 1986. Contract AC07-76ID01570. 14p. (CONF-860638—1). NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86003228.

From American control conference; Seattle, WA, USA (18 Jun 1986).

Eigenstructure control concepts work well if the feedback designer possesses a deep understanding of the physical system to be controlled. With other systems the designer may have some difficulty in selecting appropriate "desired" eigenvectors. Physical system characteristics may place constraints on the "achievable" eigenvectors which are not obvious to the control system designer; these constraints can complicate the design process. However, achievable eigenvectors must lie within the column space of an easily computed matrix. It is found that examining the singular value decomposition of this matrix helps one understand a physical system and appreciate what can be accomplished with feedback control. An example problem illustrates the idea and shows that the decomposition may broaden the range of control systems which are easily designed with the eigenstructure approach. 10 refs., 6 figs.

33468 (GEPP-TIS—961) Implementation of disk sharing between two network management consoles on an Ungermann-Bass local area network. Kaplan, C.S.; Farr, D. (General Electric Co., Largo, FL (USA). Neutron Devices Dept.). 28 Apr 1986. Contract AC04-76DP00656. 11p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010265.

In a large Ungermann-Bass Local Area Network (LAN), the network management console (NMC) poses several administrative problems. With over 1500 ports, network reloads and software backups require unacceptable periods of time. If the NMC suffers fatal hardware errors, it takes two hours to rebuild the Net/One software and restore network load files from floppy diskettes. If the network interface unit card in the NMC has failed, the network is left without a management console unless a spare is available. To eliminate these problems a separate personal computer (PC) network has been installed. The PC network consists of a central file server connected to two NMC workstations. Using this redundant system configuration, two NMCs can do network reloads simultaneously from the same data base, or network administrative functions can be done on one NMC while the other stays in download server mode.

33469 (INS-P—163) Potassium-argon age calculations. A revised evaluation of analytical errors. Hulston, J.R. (Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Inst. of Nuclear Sciences). Jun 1984. 20p. NTIS (US Sales Only), PC A02/MF A01. File Number DE86702205.

The potassium-argon method of dating rocks and minerals is summarised. The equations of the age calculation, when the mass spectrometer argon-38 isotope dilution technique is used, are described and the analytical errors evaluated. It is found that the error analysis described in the most commonly used textbook gives error estimates which are satisfactory for most samples but are excessively low for small young samples. A Vax-BASIC program ARGON is described which accepts mass spectrometer peak height information together with potassium content and other relevant information and calculates the age and analytical error. A secondary file is produced which provides a summary table of results. 4 refs; 2 figs; 3 tables.

33470 (IPEN-Pub—72) Acceleration of the nodal program FERM. Nakata, H. (Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo (Brazil)). 1985. 14p. (In Portuguese). NTIS (US Sales Only), PC A02/MF A01. File Number DE86702102.

Acceleration of the nodal FERM was tried by three acceleration schemes. Results of the calculations showed the best acceleration with the Tchebyshev method where the savings in the computing time were of the order of 50%. Acceleration with the Asymptotic Source Extrapoltation Method and with the Coarse-Mesh Rebalancing Method did not result in any improvement on the global computational time, although a reduction in the number of outer iterations was observed.

33471 (LA-UR—86-1151) Hypercube project and a simulator for a hypercube of computers. Hong, J.P.; Tomlinson, R.D.; Patel, N.; Pollard, L.H. (Los Alamos National Lab., NM (USA)). 1985. Contract W-7405-ENG-36. 9p. (CONF-8508173—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010164.

From Conference on hypercube microprocessors; Knoxville, TN, USA (1 Aug 1985).

The Los Alamos National Laboratory and the University of New Mexico are working on HC, a hypercube project for large problems. A hypercube of 1024 nodes is being designed; implementation of a machine of at least 16 nodes is underway. The nodes of the machine are complete computer systems, including mass storage and a large main memory. The computational abilities of each node are enhanced by using a detached instruction fetch-execute-store organization. This allows the execution rate to achieve a consistently high level, approaching 90% of optimum. Trade-offs in the implementation methods indicate the speeds available with acceptable hardware investments. A simulator has been written which allows execution of high level programs on a hypercube organization. The simulator has shown that programs prepared for execution on a single stream machine can be easily modified to use the resources of a parallel machine, and that the results are identical to previous executions. 20 refs., 3 figs.

33472 (LA-UR—86-1176) Text and graphics at Los Alamos: a system viewpoint. Vigil, M.; Bouchier, S.C. (Los Alamos National Lab., NM (USA)). 1986. Contract W-7405-ENG-36. 8p. (CONF-8604177—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86010169.

From ACM mountain regional conference; Santa Fe, NM, USA (11 Apr 1986).

At Los Alamos National Laboratory, a computerized document preparation system is being developed to produce publication-quality documents integrating text and graphics. Mixing text and graphics involves a combination of two different technologies; thus the project has presented numerous and interesting challenges. The requirements, issues, solutions, and continuing concerns of the system development are described. The particular challenges encountered in fitting the document system into the Laboratory's diverse computing network are explained. The paper itself is an example of the type of document the system can produce. 3 figs.

33473 **(LA-UR—86-1288) Machine learning using a higher order correlation network.** Lee, Y.C.; Doolen, G.; Chen, H.H.; Sun, G.Z.; Maxwell, T.; Lee, H.Y. . (Los Alamos National Lab., NM (USA); Maryland Univ., College Park (USA)). 1986. Contract W-7405-ENG-36. 41p. (CONF-8605108—1). NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010183.

From Evolution, games, and learning conference; Los Alamos, NM, USA (20 May 1986).

A high-order correlation tensor formalism for neural networks is described. The model can simulate auto associative, heteroassociative, as well as multiassociative memory. For the autoassociative model, simulation results show a drastic increase in the memory capacity and speed over that of the standard Hopfield-like correlation matrix methods. The possibility of using multiassociative memory for a learning universal inference network is also discussed. 9 refs., 5 figs.

33474 **(NEANDC(E)—231/L) Solution of ordinary differential equations using power series with decomposed coefficients. Part 1. Mathematical analysis.** Schett, A.; Collin, M.; Perrier, R. (CEA Centre d'Etudes de Bruyeres-le-Chatel, 92 - Montrouge (France)). Oct 1985. 139p. (INDC(FR)—64/L). NTIS (US Sales Only), PC A07/MF A01. File Number DE86901284.

The solution functions of systems of ordinary differential equations are represented in form of power series of which the coefficients C/sub n/ are decomposed into three parts C/sub n/ = (A.B.V)/sub n/: A reflects the form of the system, B its strength of coupling and V the initial values. The component A and in most practical cases also the component B remain constant during integration. Recurrence relations for the key-component A are derived for various types of systems. They have the form A/sub n+1/ = f/(A/sub n/). The knowledge of A/sub n/permits a direct, non-recursive computation of the component B and V. This decomposition of the coefficients C/sub n/ permits economical integration of a system (computation of V only instead of C/sub n/ as a whole at each integration step, reduction of coefficients to be computed owing to identities resulting from symmetries of the system), is convenient due to its transparency (intervention on B does not affect A and in most cases also not V), and reveals interesting mathematical information (mathematical significance of A). The formalism is illustrated by examples. 25 refs., 18 tabs.

33475 **(ORNL/TM—9919) Development and evaluation of DOTTOR, a computer code to couple two-dimensional to three-dimensional discrete ordinates calculations.** Thompson, J.L.; Emmett, M.B.; Dodds, H.L. Jr. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 83p. NTIS, PC A05/MF A01; GPO Dep. File Number DE86010081.

A method has been developed to couple two-dimensional (2-D) to three-dimensional (3-D) discrete ordinates transport calculations. This method is useful for problems in which a 3-D Cartesian (X-Y-Z geometry) region of interest is very far from a point source. A 3-D solution from the source including the region of interest is prohibited due to the large computing cost of such calculations. The problem is solved by first performing a 2-D discrete ordinates calculation from the source past the region of interest. The results of the 2-D calculations are transformed into a boundary condition on the surface of the 3-D region of interest. This transformation or coupling method is developed and implemented in the DOTTOR computer code. The boundary condition is then used for a subsequent 3-D discrete ordinates calculation in the region of interest. Simple test problems were used to evaluate the accuracy and speed (i.e., computing cost) of the DOTTOR code. The evaluation indicates that the DOTTOR code produces accurate results with acceptable computing costs. The algorithm chosen showed a significant speed advantage over others tested when applied to large problems. 9 refs., 13 refs., 8 tabs.

33476 **(ORNL/TM—9962) Sparse Cholesky factorization on a local-memory multiprocessor.** George, A.; Heath, M.T.; Liu, J.; Ng, E. (Oak Ridge National Lab., TN (USA)). Apr 1986. Contract AC05-84OR21400. 22p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010082.

The problem of factoring a large sparse positive definite matrix is implemented on a multiprocessor system. The processors are assumed to have substantial local memory but no globally shared memory. They communicate among themselves and with a host processor through message passing. The primary interest is in designing an algorithm which exploits parallelism, rather than in exploiting features of the underlying topology of the hardware. However, part of the study is aimed at determining, for certain sparse matrix problems, whether hardware based on the binary hypercube topology adequately supports the communication requirements for such problems. Numerical results from experiments running on a multiprocessor simulator are included. 20 refs., 7 figs., 5 tabs.

33477 **(ORNL/TM—9966) Message-passing multiprocessor simulator.** Dunigan, T.H. (Oak Ridge National Lab., TN (USA)). May 1986. Contract AC05-84OR21400. 31p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010076.

The structure and use of a message-passing multiprocessor simulator are described. The simulator provides a multitasking environment for the development of algorithms for parallel processors using either shared or local memories. The simulator may be used from C or FORTRAN and provides a library of subroutines for task control and message passing. The simulator produces a trace file that can be used for debugging, performance analysis, or graphical display. 9 refs., 7 figs.

33478 **(RHO-FI-SA—6-P) Communicating with the IBM-PC on the Xerox Ethernet local area network.** Jacobsen, P.H. (Rockwell International Corp., Richland, WA (USA). Rockwell Hanford Operations). Feb 1986. Contract AC06-77RL01030. 17p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86009842.

Topics covered in these viewgraphs are equipment needed and conditions necessary for communications, software and interface board capabilities, installation of the system, transferring files between the IBM PC and the Xerox system, and converting file type to ASCII format. (DWL)

33479 **(SAND—86-0037) Set of FORTRAN routines for multitask timing analysis on shared memory machines.** Montry, G.R. (Sandia National Labs., Albuquerque, NM (USA)). 31 Mar 1986. Contract AC04-76DP00789. 43p. NTIS, PC A03/MF A01; 1; GPO Dep. File Number DE86010310.

A set of FORTRAN-based timing routines has been written for shared memory parallel processors. These routines are designed to measure the performance of multitasking codes on machines with different hardware configurations. Complete run-time histories of all executing tasks are provided in a postmortem summary. The package is able to provide both processing time and elapsed time statistics for each task subject to functional hardware constraints. Source code for the ELXSI 6400 version of the package is included in an Appendix. 3 refs., 4 figs.

33480 **(SAND—86-0378) Guidelines for computer software development in Directorate 1500.** Rottler, J.S.; Gilkey, A.P.; Hopkins, P.L. (Sandia National Labs., Albuquerque, NM (USA)). Apr 1986. Contract AC04-76DP00789. 23p. NTIS, PC A02/MF A01; GPO Dep. File Number DE86010312.

Guidelines for writing uniform FORTRAN programs and the associated documentation are described. The goal of these programming guidelines is to aid in producing well structured and ac-

curately documented programs which will facilitate future software modifications and transitions to new operating systems. These guidelines have been divided into three categories. The first describes key ideas that relate to the software development process, the second describes guidelines for writing documentation, and the third describes programming conventions. 8 refs.

33481 **(SAND—86-0525) GRAPH III: a digitizing and graph plotting program.** Selleck, C.B. (Sandia National Labs., Albuquerque, NM (USA)). Mar 1986. Contract AC04-76DP00789. 59p. NTIS, PC A04/MF A01; GPO Dep. File Number DE86010628.

GRAPH is an interactive program that allows the user to perform two functions. The first is to plot two dimensional graphs and the second is to digitize graphs or plots to create data files of points. The program is designed to allow the user to get results quickly and easily. It is written in RATIV (a FORTRAN preprocessor) and is currently in use at Sandia under VMS on a VAX computer and CTSS on a Cray supercomputer. The program provides graphical output through all of the Sandia Virtual Device Interface (VDI) graphics devices. 2 refs., 3 figs., 3 tabs.

33482 **(UCID—20546) Supplement to PADL-2 user's manual, PADL-2/CRAY-1 version.** Kalibjian, J.R. (Lawrence Livermore National Lab., CA (USA)). 7 Feb 1986. Contract W-7405-ENG-48. 13p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010261.

This report is a supplement to the "PADL-2 User's Manual," published by the Production Automation Project at the University of Rochester in May 1983. It documents the changes made to the PADL-2 (Part and Assembly Description Language) user interface to adapt it to the LTSS operating system on the CRAY-1 at the Lawrence Livermore National Laboratory. 9 refs., 2 figs.

33483 **(UCID—20643) User systems guidelines for software projects.** Abrahamson, L. (ed.). (Lawrence Livermore National Lab., CA (USA)). 1 Apr 1986. Contract W-7405-ENG-48. 157p. NTIS, PC A08/MF A01; 1; GPO Dep. File Number DE86010490.

This manual presents guidelines for software standards which were developed so that software project-development teams and management involved in approving the software could have a generalized view of all phases in the software production procedure and the steps involved in completing each phase. Guidelines are presented for six phases of software development: project definition, building a user interface, designing software, writing code, testing code, and preparing software documentation. The discussions for each phase include examples illustrating the recommended guidelines. 45 refs. (DWL)

33484 **(UCID—20645-Rev.1) Math and statistics bulletin board user's guide. Revision 1.** Perra, J.J.; Seager, M.K.; Short, C.M. (Lawrence Livermore National Lab., CA (USA)). 23 Apr 1986. Contract W-7405-ENG-48. 18p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010263.

This user's guide describes the nature scoped of the bulletin board, the software available for downloading, file transfer procedures, and restriction of access to proprietary software. Specific information is provided on running the bulletin board. This information includes setting up hardware and software, starting the emulator, dialing in to the bulletin board, using the main menu, sending and receiving personal and broadcast mail, and listing, downloading, and uploading routines.

33485 **(UCID—20746) History of the Wilson-Fowler spline.** Fritsch, F.N. (Lawrence Livermore National Lab., CA (USA)). Apr 1986. Contract W-7405-ENG-48. 16p. NTIS, PC A02/MF A01; 1; GPO Dep. File Number DE86010264.

The Wilson-Fowler spline (abbreviated WF-spline) was introduced in the early 1960's as a means for drawing a smooth curve through a planar set of data. It has been used as the spline entity in the APT system's TABCYL since its inception. The history of the WF-spline is briefly described and a chronologically arranged annotated bibliography of all known references to it are featured. 6 refs.

33486 **(UCRL—93581) Shadows for bump-mapped surfaces.** Max, N.L. (Lawrence Livermore National Lab., CA (USA)). 5 Nov 1985. Contract W-7405-ENG-48. 14p. (CONF-8604167—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86009721.

From Tokyo meeting on computer graphics; Tokyo, Japan (22 Apr 1986).

Bump mapping produces realistic shading by perturbing normal vectors to a surface, but does not show the shadows that the bumps cast on nearby parts of the same surface. In this paper, these shadows are found from precomputed tables of horizon angles, listing, for each position entry, the elevation of the horizon in a sampled collection of directions. These tables are made for bumps on a standard flat surface, and then a transformation is developed so that the same tables can be used for an arbitrary curved parameterized surface patch. This necessitates a new method for scaling the bump size to the patch size. 7 refs., 8 figs.

33487 **(UCRL—94000) Time integration and conjugate gradient methods for the incompressible Navier-Stokes equations.** Gresho, P.M. (Lawrence Livermore National Lab., CA (USA)). Jan 1986. Contract W-7405-ENG-48. 25p. (CONF-860681—1). NTIS, PC A02/MF A01; GPO Dep. File Number DE86007177.

From 6. international conference on finite elements in water; Lisbon, Portugal (1 Jun 1986).

This paper addresses one class of iterative methods that are promising for cost effective Navier-Stokes simulations. The approach is based on the conjugate gradient (CG) method for solving linear algebraic systems with a symmetric positive-definite (SPD) matrix. These methods have many important characteristics: monotone convergence (in an appropriate error norm), optimal error minimization, finite termination, the direct exploitation of sparseness in the matrix, and no need to estimate "iteration parameters." 46 refs., 1 tab. (DWL)

33488 **(UFRJ-COPPE-PEN—131) Application of the explicit method for analysing intersystem dependencies in the evaluation of event trees.** Oliveira, L.F.S. de; Frutuoso e Melo, P.F.F.; Lima, J.E.P.; Stal, I.L. (Rio de Janeiro Univ. (Brazil). Coordenacao dos Programas de Pos-graduacao de Engenharia). 1985. 61p. NTIS (US Sales Only), PC A04/MF A01. File Number DE86702105.

A computational application of the explicit method for analyzing event trees in the context of probabilistic risk assessments is discussed. A detailed analysis of the explicit method is presented, including the train level analysis (TLA) of safety systems and the impact vector method. It is shown that the penalty for not adopting TLA is that in some cases non-conservative results may be reached. The impact vector method can significantly reduce the number of sequences to be considered, and its use has inspired the definition of a dependency matrix, which enables the proper running of a computer code especially developed for analysing event trees. The code has been extensively used in the Angra 1 PRA currently underway. In its present version it gives as output the dominant sequences for each given initiator, properly classiying them in core-degradation classes as specified by the user.

33489 **A 32-bit FASTBUS computer.** Blossom, J.M.; Hong, J.P.; Kellner, R.G. (Los Alamos National Lab., E-10 Data Systems, MS K488, Los Alamos, NM 87545). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-33**: No. 1, vp(Feb 1986). (CONF-851009—).

From IEEE nuclear science symposium; San Francisco, CA, USA (23 Oct 1985).

Los Alamos National Laboratory is building a 32-bit FASTBUS computer using the NATIONAL SEMICONDUCTOR 32032 central processing unit (CPU) and containing 16 million bytes of memory. The board can act both as a FASTBUS master and as a FASTBUS slave. It contains a custom direct memory access (DMA) channel which can perform 80 million bytes per second block transfers across the FASTBUS. The FASTBUS interface is based on programmable array logic.

33490 FASTRUN - a high performance computing device for molecular mechanics using a pipeline architecture. Dimmler, D.G.; Fine, R. (Brookhaven National Lab., Upton, NY 11973-5000). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Nuclear Science;* **NS-33**: No. 1, vp(Feb 1986). (CONF-851009—). Contract AC02-76CH00016.

From IEEE nuclear science symposium; San Francisco, CA, USA (23 Oct 1985).

A deep, synchronous pipeline architecture has been selected for a computing device with a power of 500 Million floating point operations per second (MFlops). The device calculates the forces and energy due to pair-wise interactions of many objects in a system. Considerations relating to application specific high-performance computer architectures are addressed. In addition, topics specifically relating to very deep, synchronous unidirectional pipelines are discussed. A key element of the device, a quadratic interpolator based on a lookup table, has been developed and tested. Five of these interpolators with a total computing power of 280 Mflops will be employed in the device.

9903 Information Handling

33491 (DOE/MA—0048/4) Information technology resources long-range plan, FY 1987-FY 1991. (USDOE Assistant Secretary for Management and Administration, Washington, DC. Office of Computer Services and Telecommunications Management). Dec 1985. 228p. NTIS, PC A11/MF A01; GPO Dep. File Number DE86010457.

Objective of this Plan is to describe the information technology resources and capabilities of the Department, the future requirements, and the strategies and plans to satisfy the identified requirements. The long-range planning process provides the systematic means to meet this objective and assists the Department in assuring that information technology support is provided in an efficient, effective, and timely manner so that the programmatic missions can be accomplished. Another objective of the Plan is to promote better understanding, both within and external to the Department, of its information technology environment, requirements, problems, and recommended solutions. The Plan covers the five-year period from fiscal year 1987 through 1991. It takes into consideration the information technology resource requirements of more than 52 different Departmental components and contractors. The IS section and resource identification is limited to business and project management type applications used by Departmental components.

33492 Use of selected toxicology information resources in assessing relationships between chemical structure and biological activity. Wassom, J.S. (Oak Ridge National Lab., TN). *Environmental Health Perspectives;* **61**: 287-294(Sep 1985).

This paper addresses the subject of the use of the selected toxicology information resources in assessing relationships between chemical structure and specific end points. To assist the researcher in how to access the primary literature of genetic toxicology, teratogenesis, and carcinogenesis, three specific specialized information centers are discussed - Environmental Mutagen Information Center, Environmental Teratology Information Center, and Environmental Carcinogenesis Information Center. Also included are descriptions of information resources that contain evaluated (peer-reviewed) biological research results. The US Environmental Protection Agency Genetic Toxicology Program, the International Agency for Research on Cancer Monographs, and the Toxicology Data Bank are the best sources currently available to obtain peer-reviewed results for compounds tested for genotoxicity, carcinogenicity, and other toxicological end points. The value of published information lies in its use. It has become evident that most information cannot be accepted at face value for interpretation and analysis when subjected to stringent quality evaluation criteria. This deficit can be corrected by rigid editorship and the cognizance of authors. Increased interest in alternative methods to in vivo animal testing will be exemplified by use of short-term bioassays and in structure-activity relationship studies. With respect to this latter area, it must be remembered that mechanically (computer generated) derived data cannot substitute, at least at this stage, for data obtained from actual animal testing. The future of structure-activity relationship studies will rest only in their use as a predictive tool.

CORPORATE AUTHOR INDEX

In the Corporate Author Index, report literature is indexed using the name of the organization or institution responsible for issuing the report. Headings are provided for all report literature and for published literature for which a corporate approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate heading gives the document title and the volume and abstract numbers. The document type, e.g., R for Report; country of publication, e.g., US; and language of the document, e.g., In German, are given in parentheses at the end of the entry. If no language statement appears, the language is English. Tables of document types and country of publication codes appear after the indexes.

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Measurement of observables in the pion-nucleon system and investigation of charge symmetry in ^{3}He and ^{3}H. Progress report, March 1, 1985-February 28, 1986, 11:32982 (R;US)

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The title may be supplemented with additional words, or a phrase, if it appears additional information would be helpful. In cases for which the title contains little or no information related to the subject entry, it may be replaced entirely by the supplementary information. A qualifier is not always required, and in such cases the title will follow the unqualified subject descriptor.

The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processes applied to, the subject term.

Index entries are selected to indicate the important ideas and concepts presented in a document, rather than words that may appear in the text. Within the available thesaurus terms, the most probable or logical place to look for typical information is selected. "See references" are included to guide users from synonymous terms or phrases to the descriptor selected as a subject heading for the concept (e.g., Pipeline Quality Gas, see HIGH BTU GAS). "See also references" are used to indicate where to find references to subject concepts that are narrower, broader, or related to a particular subject heading. To complete an exhaustive search of a given subject, all such headings should be reviewed. Copies of DOE/TIC-7000, the Subject Thesaurus, are available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161.

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613-3479	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010774	STD -38	11:32414
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85-145	NTIS (US Sales Only), PC A03/MF A01; 1	DE86752002	MN -95d	11:32037
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85-156	NTIS (US Sales Only), PC A07/MF A01; 1	DE86752001	MN -92	11:31415
85-157	NTIS (US Sales Only), PC A04/MF A01; 1	DE86752004	MN -95d	11:32038
85-158	NTIS (US Sales Only), PC A06/MF A01; 1	DE86752005	MN -61G	11:31674
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51904	*See* NUREG/CR-4319	TI86009630	MN -41	11:31605
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037/ 85	NTIS (US Sales Only), PC A03/MF A01	DE86701957	MN -34D	11:32998
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85-16	NTIS (US Sales Only), PC A03/MF A01	DE86702083	MN -37	11:32643
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130/ 85	NTIS (US Sales Only), PC A05/MF A01	DE86702011	MN -25	11:32157
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CONF-800434-	(CSNI specialist meeting on nuclear aerosols in reactor safety, Gatlinburg, TN, USA, 15-17 Apr 1980)			
	See NUREG/CR-1724	TI86002655	MN -80	11:31913
CONF-8010385-	(4. annual meeting of the National Association in Social Science Research, Rio de Janeiro, Brazil, 29-31 Oct 1980)			
1	*See* INIS-BR-467	DE86702100	MN -2	11:31609
CONF-8103198-	(National conference on grain marketing patterns, Memphis, TN, USA, 11-13 Mar 1981)			
	See TVA/OACD-85/4	DE86901288	MN -13	11:32842
CONF-810545-	(3. conference on waste heat management and utilization, Miami, FL, USA, 12 May 1981)			
12	*See* K/ET-5021	E 1.99: DE86009958	MN -12	11:31989
CONF-8105272-	(Congress on hypotheses of a fluvial oasis on the Chiascio River, Bastia Umbra, Italy, 29-30 May 1981)			
1	*See* ENEA-RT/FARE-SIN-81-2	DE86900989	MN -11	11:32777
CONF-8205314-	(9. international geochemical exploration symposium, Saskatoon, Canada, 12-14 May 1982)			
	J. Geochem. Explor., 19: No. 1-3, 723-743(1983)			11:31472
CONF-8209296-	(Conference on application of Monte Carlo method in modelling physical and physico-chemical processes, Prague, Czechoslovakia, 9-10 Sep 1982)			
	See INIS-mf-10110	DE86701972	MN -34C	11:33218
CONF-8212111-	(Energy efficiency of solar systems meeting, Brugg-Windisch, Switzerland, 9 Dec 1982)			
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CONF-8306279-	(ENVRISK '83 - international workshop on environmental impacts of energy systems, San Miniato, Pisa, Italy, 1 Jun 1983)			
1	*See* ENEA-RT-PAS-85/22	DE86901293	MN -41	11:32844
CONF-8307163-	(6. international seminar on high energy physics and quantum field theory, Protvino, USSR, 1 Jul 1983)			
Vol.2	*See* INIS-SU-320	DE86780457	MN -34D	11:32976
CONF-8310245-	(Conference on Hadron substructure in nuclear physics, McCormick's Creek S.P., IN, USA, 19-21 Oct 1983)			
	AIP Conf. Proc., 110: No. 1, 187-206(20 Feb 1984)			11:33202
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CONF-840113-	(Symposium on space nuclear power systems, Albuquerque, NM, USA, 10-13 Jan 1984)			
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CONF-840275-	(Workshop on anti pp options for the SSC, Chicago, IL, USA, 13-17 Feb 1984)			
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CONF-8404124-	(SPIE technical symposium, Arlington, VA, USA, 29 Apr-4 May 1984)			
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CONF-840612-	(Air Pollution Control Association annual meeting, San Francisco, CA, USA, 25-28 Jun 1984)			
	Proc., Annu. Meet., Air Pollut. Control Assoc., 5: 16(1984)			11:31786
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CONF-840779-	(25. Liege international astrophysical colloquium, Leige, Belgium, 10-13 Jul 1984)			
3-Prepr.	*See* NORDITA-84/34-Prepr.	DE86751767	MN -34B	11:32919
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3-Prep.	*See* NORDITA-84/36-Prepr.	DE86751762	MN -34B	11:32920

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CONF-8407160-	(7. seminar on problems of high energy physics and quantum field theory, Protvino, USSR, 1 Jul 1984)			
Vol.1	*See* INIS-SU-321	DE86780458	MN -34D	11:32977
CONF-8407162-	(Fission-track dating workshop, Troy, NY, USA, 31 Jul-3 Aug 1984)			
	Nucl. Tracks, 10: No. 3, 447-459(1985)			11:31836
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8-Rev.	*See* LBL-17598-Rev.	E 1.99: DE86009367	MN -41	11:32713
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	American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017			11:31329
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1-Summ.	*See* CENBG-8510	DE86751803	MN -34A	11:32929
CONF-850237-	(International workshop on measuring thermal performance characteristics of windows, Gaithersburg, MD, USA, 26-27 Feb 1985)			
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	Fusion Technol., 8: No. 2, 2491-2494(Sep 1985)			11:33414
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	Fusion Technol., 8: No. 2, 2133-2142(Sep 1985)				11:33429
	Fusion Technol., 8: No. 2, 2175-2183(Sep 1985)				11:33430
	Fusion Technol., 8: No. 2, 2168-2174(Sep 1985)				11:33431
	Fusion Technol., 8: No. 2, 2184-2189(Sep 1985)				11:33432
	Fusion Technol., 8: No. 2, 2190-2195(Sep 1985)				11:33433
	Fusion Technol., 8: No. 2, 2239-2244(Sep 1985)				11:33434
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	Fusion Technol., 8: No. 2, 2293-2298(Sep 1985)				11:33436
	Fusion Technol., 8: No. 2, 2299-2305(Sep 1985)				11:33437
	Fusion Technol., 8: No. 2, 2318-2329(Sep 1985)				11:33438
	Fusion Technol., 8: No. 2, 2360-2365(Sep 1985)				11:33439
	Fusion Technol., 8: No. 2, 2366-2372(Sep 1985)				11:33440
	Fusion Technol., 8: No. 2, 2384-2387(Sep 1985)				11:33441
CONF-8504174-	(Energy sources: conservation and renewables, Washington, DC, USA, 27-28 Apr 1985)				
4	*See* LBL-20213	E 1.99:	DE86009924	MN -95d	11:32070
CONF-850504-	(Particle accelerator conference, Vancouver, Canada, 13-16 May 1985)				
	IEEE Trans. Nucl. Sci., NS-32: No. 5, 1812-1813(Oct 1985)				11:33413
CONF-850535-	(European symposium on few-body physics - mesons and light nuclei III, Bechyne Castle, Czechoslovakia, 27 May-1 Jun 1985)				
4	*See* CEA-CONF-7967		DE86751778	MN -34C	11:33100
CONF-850565-	(13. biennial lignite symposium on technology and use of low-rank coals, Bismarck, ND, USA, 21-23 May 1985)				
Vol.2	*See* DOE/METC-86/6036-Vol.2	E 1.99:	DE86001077	STD -90	11:31357
CONF-8505130-	(6. topical conference on radio frequency plasma heating, Pine Mountain, GA, USA, 13-15 May 1985)				
	AIP Conf. Proc., 129: No. 1, 8-11(Jul 1985)				11:33357
	AIP Conf. Proc., 129: No. 1, 28-31(Jul 1985)				11:33358
	AIP Conf. Proc., 129: No. 1, 36-39(Jul 1985)				11:33359
	AIP Conf. Proc., 129: No. 1, 65-66(Jul 1985)				11:33360
	AIP Conf. Proc., 129: No. 1, 67-70(Jul 1985)				11:33361
	AIP Conf. Proc., 129: No. 1, 75-78(Jul 1985)				11:33362
	AIP Conf. Proc., 129: No. 1, 79-82(Jul 1985)				11:33363
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	AIP Conf. Proc., 129: No. 1, 91-95(Jul 1985)				11:33365
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	AIP Conf. Proc., 129: No. 1, 122-130(Jul 1985)				11:33367
	AIP Conf. Proc., 129: No. 1, 131-134(Jul 1985)				11:33368
	AIP Conf. Proc., 129: No. 1, 135-138(Jul 1985)				11:33369
	AIP Conf. Proc., 129: No. 1, 139-142(Jul 1985)				11:33370
	AIP Conf. Proc., 129: No. 1, 147-150(Jul 1985)				11:33371
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	AIP Conf. Proc., 129: No. 1, 158-161(Jul 1985)				11:33373
	AIP Conf. Proc., 129: No. 1, 162-165(Jul 1985)				11:33374
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	AIP Conf. Proc., 129: No. 1, 182-185(Jul 1985)				11:33376
	AIP Conf. Proc., 129: No. 1, 194-197(Jul 1985)				11:33377
	AIP Conf. Proc., 129: No. 1, 218-221(Jul 1985)				11:33378
	AIP Conf. Proc., 129: No. 1, 222-226(Jul 1985)				11:33379
	AIP Conf. Proc., 129: No. 1, 235-242(Jul 1985)				11:33380
	AIP Conf. Proc., 129: No. 1, 103-106(Jul 1985)				11:33381
	AIP Conf. Proc., 129: No. 1, 61-64(Jul 1985)				11:33442
	AIP Conf. Proc., 129: No. 1, 95-98(Jul 1985)				11:33443
	AIP Conf. Proc., 129: No. 1, 107-110(Jul 1985)				11:33444
	AIP Conf. Proc., 129: No. 1, 170-173(Jul 1985)				11:33445
CONF-8505158-	(ASTM symposium on community toxicity testing, Colorado Springs, CO, USA, 6-7 May 1985)				
2	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010038	MN -11	11:31349
CONF-8505255-	(Special colloquium: a tribute to Niels Bohr, Geneva, Switzerland, 6 May 1985)				
1	*See* CERN-85-17		DE86701917	MN -34D	11:33252
CONF-8505256-	(IAA conference on instrumental activation analysis, Klucenice, Czechoslovakia, 12-15 May 1985)				
Abst.	*See* INIS-mf-10111		DE86701997	MN -4	11:32330
CONF-8505265-	(Conference on antinucleon and nucleon-nucleus interaction, Telluride, CO, USA, 18-21 May 1985)				
1	*See* CEA-CONF-7963		DE86751783	MN -34C	11:33174
CONF-850672-	(2. international conference on nucleus-nucleus collisions, Visby, Sweden, 10-14 Jun 1985)				
15	*See* GANIL-P-85-10		DE86751807	MN -34C	11:33132
16-Summ.	*See* ISN-85-11		DE86751808	MN -34C	11:33135
17-Summ.	*See* ISN-85-12		DE86751809	MN -34C	11:33122
CONF-8506152-	(CEBAF summer workshop, Newport News, VA, USA, 3-7 Jun 1985)				
5	*See* CEA-CONF-8040		DE86751782	MN -34C	11:33175

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CONF-8506156-	(Los Alamos workshop on relativistic dynamics and quarks in nuclear physics, Los Alamos, NM, USA, 10-14 Jun 1985)				
2	*See* DOE/ER/02853-28	E 1.99:	DE86010633	MN -34D	11:33177
CONF-8506270-	(12. annual conference of Plasma Physics Group of the Institute of Physics, Glasgow, UK, 26-28 Jun 1985)				
	Plasma Phys. Control. Fusion, 27: No. 12A, 1449-1459(Dec 1985)				11:33353
CONF-8506279-	(Seminar on higher flexibility of industrial robots in submerged-arc welding, Frankfurt am Main, F.R. Germany, 10-11 Jun 1985)				
1	*See* GKSS-85/E/52		DE86752027	MN -38	11:32522
CONF-850702-	(11. Europhysics conference on nuclear physics with electromagnetic probes, Paris, France, 1-6 Jul 1985)				
5	*See* CEA-CONF-8060		DE86751781	MN -34C	11:33124
CONF-8507117-	(29. Scottish Universities summer school in physics: laser plasma interactions, St. Andrews, Scotland, 28 Jul-10 Aug 1985)				
1	*See* UCRL-94360	E 1.99:	DE86009399	MN -20f	11:33313
CONF-850819-	(12. international symposium on lepton and photon interactions at high energies, Kyoto, Japan, 19-24 Aug 1985)				
15	*See* HD-PY-86/01		DE86751759	MN -34D	11:32984
CONF-850830-	(10. international colloquium on dynamics of explosions and reactive systems, Berkeley, CA, USA, 4-9 Aug 1985)				
8	*See* UCRL-91994	E 1.99:	DE86010159	MN -4	11:32399
9	*See* SAND-85-0760C	E 1.99:	DE86010469	MN -38	11:32404
CONF-8508108-	(2. international meeting on metallothionein, Zurich, Switzerland, 21-24 Aug 1985)				
3	*See* LA-UR-86-1149	E 1.99:	DE86010163	MN -48	11:32799
CONF-8508139-	(10. Hawaii topical conference in particle physics, Honolulu, Hawaii, 26-31 Aug 1985)				
2	*See* KFK-4035		DE86901358	MN -34D	11:32989
CONF-8508173-	(Conference on hypercube microprocessors, Knoxville, TN, USA, 1 Aug 1985)				
1	*See* LA-UR-86-1151	E 1.99:	DE86010164	MN -32	11:33471
CONF-850942-	(190. American Chemical Society national meeting, Chicago, IL, USA, 8-13 Sep 1985)				
54-Rev.1	*See* UCRL-92492-Rev.1	E 1.99:	DE86009603	MN -34C	11:33197
CONF-8509159-	(17. international summer school on nuclear physics, Mikolajki, Poland, 2-14 Sep 1985)				
5	*See* KFK-4007		DE86751754	MN -34C	11:33193
CONF-8509232-	(Conference on Josephson effect: achievements and trends, Torino, Italy, 16-21 Sep 1985)				
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010320	MN -25	11:33245
CONF-8509237-	(National congress of the French Physical Society, Nice, France, 9-13 Sep 1985)				
2	*See* CEA-CONF-8145		DE86751779	MN -34C	11:33176
CONF-8509255-	(Synchrotron radiation sources and their applications conference, Aberdeen, Scotland, 14-18 Sep 1985)				
2-Rev.	*See* LBL-20833-Rev.	E 1.99:	DE86009906	MN -28	11:33260
3-Rev.	*See* LBL-20835-Rev.	E 1.99:	DE86009905	MN -28	11:33261
CONF-8509269-	(1. topical European meeting on quark structure of matter, Strasbourg, France, 26 Sep-1 Oct 1985)				
1	*See* BONN-HE-85-36		DE86751733	MN -34D	11:32980
CONF-851009-	(IEEE nuclear science symposium, San Francisco, CA, USA, 23-25 Oct 1985)				
	IEEE Trans. Nucl. Sci., NS-33: No. 1, vp(Feb 1986)				11:33340
	IEEE Trans. Nucl. Sci., NS-33: No. 1, vp(Feb 1986)				11:33341
	IEEE Trans. Nucl. Sci., NS-33: No. 1, vp(Feb 1986)				11:33342
	IEEE Trans. Nucl. Sci., NS-33: No. 1, vp(Feb 1986)				11:33343
	IEEE Trans. Nucl. Sci., NS-33: No. 1, vp(Feb 1986)				11:33489
	IEEE Trans. Nucl. Sci., NS-33: No. 1, vp(Feb 1986)				11:33490
CONF-851022-	(BNES conference on boiler dynamics and control in nuclear power stations, Yorkshire, UK, 21-25 Oct 1985)				
1	*See* AEEW-R-1966		TI86901230	ND -79	11:31838
2	*See* AEEW-R-1967		TI86901231	ND -79	11:31839
CONF-851027-	(24. Hanford life sciences symposium on health and environmental research on complex organic mixtures, Richland, WA, USA, 21-24 Oct 1985)				
10	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86008889	MN -41	11:32707
CONF-851053-	(7. international workshop on laser interaction and related plasma phenomena, Monterey, CA, USA, 28 Oct-1 Nov 1985)				
14	*See* UCRL-94454	E 1.99:	DE86010559	MN -21	11:32454
CONF-8510151-	(28. Oak Ridge National Laboratory conference on analytical chemistry, Knoxville, TN, USA, 1-3 Oct 1985)				
	Lewis Publishers, Inc., 121 S. Main Street, P.O. Drawer 519, Chelsea, MI 48118		TI86010004	ND -37	11:32654

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CONF-8510166-	(1. international information meeting on the TMI-2 accident, Washington, DC, USA, 21 Oct 1985)			
	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99: DE86010354	STD -78	11:31895
CONF-8510242-	(15. annual meeting of the Illinois Economics Association, Chicago, IL, USA, 25-26 Oct 1985)			
1-Rev.	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86009193	MN -98	11:32026
CONF-8510298-	(2. annual acid rain conference for the Southern Appalachians, Gatlinburg, TN, USA, 28-30 Oct 1985)			
Abstr.	*See* TVA/ONRED/AWR-86/11	DE86901133	MN -11	11:32731
CONF-8510308-	(Gas sampling calorimetry workshop, Batavia, IL, USA, 31 Oct-1 Nov 1985)			
1	*See* DOE/ER/40033-108	E 1.99: DE86010233	MN -28	11:32557
CONF-8511170-	(Lattice gauge theory: a challenge in large scale computing conference, Wuppertal, F.R. Germany, 5-7 Nov 1985)			
2	*See* LA-UR-86-1116	E 1.99: DE86010161	MN -34D	11:33070
CONF-860102-	(3. symposium on space nuclear power systems, Albuquerque, NM, USA, 13-16 Jan 1986)			
5	*See* EGG-M-28185	E 1.99: DE86005324	MN -80	11:31896
CONF-860111-	(11. workshop on geothermal reservoir engineering, Stanford, CA, USA, 21-23 Jan 1986)			
8	*See* LBL-21249	E 1.99: DE86009950	MN -66a	11:31767
CONF-860144-	(Workshop on atomic physics with stored cooled heavy ion beams, Oak Ridge, TN, USA, 13-15 Jan 1986)			
Summs.	NTIS, PC A19/MF A01; 1 (GPO Dep.)	E 1.99: DE86010009	MN -34A	11:32930
CONF-860150-	(Winter condensed matter physics conference: frontiers in condensed matter X-ray physics, Aspen, CO, USA, 19-25 Jan 1986)			
2	*See* LA-UR-86-1492	E 1.99: DE86010209	MN -34D	11:33073
CONF-860167-	(Recontres de Moriond workshop on massive neutrinos in particle physics and astrophysics, Tignes, Savoie, France, 25 Jan-1 Feb 1986)			
5	*See* DOE/ER/40048-21-N6	E 1.99: DE86010451	MN -34B	11:33137
CONF-860168-	(Workshop on observable standard model physics at the SSC, Los Angeles, CA, USA, 15-24 Jan 1986)			
2	*See* BNL-37928	E 1.99: DE86009918	MN -34D	11:32996
3	*See* BNL-38034	E 1.99: DE86010538	MN -34D	11:32997
CONF-860170-	(Ignition Technical Oversight Committee meeting, Austin, TX, USA, 20 Jan 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009503	MN -20	11:33393
CONF-860270-	(4. winter workshop on nuclear dynamics, Copper Mountain, CO, USA, 24-28 Feb 1986)			
7	*See* LBL-21272	E 1.99: DE86009357	MN -34C	11:33196
CONF-860272-	(Wire chamber conference, Vienna, Austria, 25-28 Feb 1986)			
6	*See* SLAC-PUB-3910	E 1.99: DE86009779	MN -34D	11:32634
CONF-860285-	(Minor scale symposium, Albuquerque, NM, USA, 24-28 Feb 1986)			
1	*See* SAND-86-0428C	E 1.99: DE86009641	MN -11	11:32693
CONF-860287-	(Utah State theoretical physics workshop, Logan, UT, USA, 24-28 Feb 1986)			
1	*See* LA-UR-86-1306	E 1.99: DE86010186	MN -34D	11:33071
2	*See* LA-UR-86-1333	E 1.99: DE86010189	MN -34D	11:33072
CONF-860288-	(4. symposium on current trends in physics, Bhubaneswar, India, 24-28 Feb 1986)			
1	*See* LA-UR-86-1262	E 1.99: DE86010179	MN -34D	11:33259
2	*See* LA-UR-86-1238	E 1.99: DE86010177	MN -34D	11:33258
CONF-860303-	(13. annual energy technology conference and exposition (ET '86), Washington, DC, USA, 17-19 Mar 1986)			
5	*See* LBL-20874	E 1.99: DE86009927	MN -95d	11:32071
CONF-860316-	(Topical meeting on short wavelength coherent radiation, Monterey, CA, USA, 24-27 Mar 1986)			
7	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010525	MN -34A	11:32450
CONF-860324-	(High temperature plasma diagnostics, Hilton Head Island, SC, USA, 9-13 Mar 1986)			
27	*See* UCRL-93890	E 1.99: DE86010537	MN -21	11:32650
CONF-860366-	(SPIE technical symposium on applications of artificial intelligence, Orlando, FL, USA, 31 Mar 1986)			
6	*See* LA-UR-86-1298	E 1.99: DE86010184	MN -38	11:32423
CONF-860396-	(Symposium on the many facets of heavy ion fusion reactions, Argonne, IL, USA, 24-26 Mar 1986)			
7	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010017	MN -34C	11:33125
CONF-8603104-	(Annual meeting of the Idaho Chapter of the American Fisheries Society, Boise, ID, USA, 6-8 Mar 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009182	MN -11	11:31980
CONF-8603106-	(Western states elk workshop, Coos Bay, OR, USA, 17-19 Mar 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009167	MN -11	11:32751
CONF-8603107-	(2. international specialty conference on meteorology of acid deposition, Albany, NY, USA, 17-20 Mar 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009188	MN -11	11:32710

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CONF-8603109-	(4. European symposium on semiconductor detectors, Munich, F.R. Germany, 3-5 Mar 1986)			
3	*See* BNL-37795	E 1.99: DE86010547	MN -48	11:32817
CONF-8603111-	(Society of Photo-Optical Instrumentation Engineers conference on electron-beam, X-ray and ion-beam techniques for submicrometer lithographies, Santa Clara, CA, USA, 9 Mar 1986)			
1	*See* UCRL-93474	E 1.99: DE86009723	MN -38	11:32434
CONF-8603115-	(Symmetries in science II, Carbondale, IL, USA, 24-26 Mar 1986)			
2	*See* BNL-38026	E 1.99: DE86010548	MN -34D	11:33173
3	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010530	MN -34	11:33046
CONF-8603116-	(4. eddy current seminar, Chilton, UK, 24-26 Mar 1986)			
1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010528	MN -20b	11:33399
CONF-860412-	(13. European conference on controlled fusion and plasma heating, Schliersee, F.R. Germany, 14-18 Apr 1986)			
4	NTIS, PC A02; 3	DE86010014	MN -20	11:33394
CONF-860413-	(2. international symposium on ceramic materials and components for engines, Luebeck-Travemuende, F.R. Germany, 14-17 Apr 1986)			
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010039	MN -25	11:32476
CONF-860414-	(6. power plant dynamics, control and testing symposium, Knoxville, TN, USA, 14-16 Apr 1986)			
4	NTIS, PC A02/MF A01 - GPO	TI86007236	MN -77	11:31893
CONF-860418-	(88. annual meeting of the American Ceramic Society, Chicago, IL, USA, 27 Apr-1 May 1986)			
5	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010520	MN -70	11:32250
CONF-860420-	(Fast burst reactor workshop, Albuquerque, NM, USA, 8-10 Apr 1986)			
2	*See* SAND-86-0901C	E 1.99: DE86009852	MN -80	11:32259
3	*See* SAND-86-0254C	E 1.99: DE86009856	MN -41	11:31957
CONF-860421-	(2. international conference on fusion reactor materials (ICFRM-2), Chicago, IL, USA, 13-17 Apr 1986)			
29	*See* LA-UR-86-1156	E 1.99: DE86010165	MN -20c	11:32197
30	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010395	MN -20c	11:32158
31	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010396	MN -20c	11:32159
32	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010393	MN -20c	11:32160
33	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010397	MN -25	11:32161
34	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010510	MN -20c	11:32162
35	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010497	MN -20c	11:32163
36	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010498	MN -20c	11:32164
37	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010394	MN -20c	11:32165
38	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010500	MN -20c	11:32416
39	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010519	MN -20c	11:32166
40	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86010507	MN -20c	11:32167
41	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010506	MN -20c	11:32168
43	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010518	MN -20c	11:33395
44	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010523	MN -20c	11:32417
45	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010521	MN -20c	11:33396
46	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010495	MN -20c	11:33397
CONF-860422-	(American power conference, Chicago, IL, USA, 14-16 Apr 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010502	MN -79	11:31842
CONF-860425-	(191. American Chemical Society national meeting, New York, NY, USA, 13-18 Apr 1986)			
26	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010511	MN -4	11:32367
27	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010508	MN -4	11:32345
CONF-860426-	(Symposium on measurement of toxic air pollutants, Raleigh, NC, USA, 27-30 Apr 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009506	MN -11	11:32708
CONF-860429-	(5. annual conference and exhibit on the incineration of low-level radioactive waste, Charlotte, NC, USA, 23-25 Apr 1986)			
1	*See* MLM-3351-OP	E 1.99: DE86010414	MN -70B	11:31515
CONF-860437-	(11. international cryogenic engineering conference, Berlin, F.R. Germany, 22-25 Apr 1986)			
1	*See* LA-UR-86-1363	E 1.99: DE86010192	MN -38	11:32403
CONF-860445-	(Materials Research Society spring meeting, Palo Alto, CA, USA, 15-18 Apr 1986)			
9	*See* SAND-85-2388C	E 1.99: DE86010094	MN -25	11:32258
10	*See* SAND-85-2391C	E 1.99: DE86010465	MN -25	11:32340
11	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010494	MN -25	11:32251
CONF-860467-	(Peer review of task group G on effects on materials of the National Acid Precipitation Assessment Program, Durham, NC, USA, 7-11 Apr 1986)			
2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010499	MN -25	11:32327
CONF-860495-	(International conference on metallurgical coatings, San Diego, CA, USA, 7-11 Apr 1986)			
6	*See* MLM-3350(OP)	E 1.99: DE86010413	MN -25	11:32152
7	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010516	MN -25	11:32228

Report Number	Availability Source	File Number	Distribution Category	Abstract Number
CONF-8604109-	(Pacific Gas and Electric (PG&E) energy expo, Oakland, CA, USA, 29 Apr-2 May 1986)			
4	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010501	MN -98E	11:31770
CONF-8604116-	(International workshop on high temperature molten salt batteries, Argonne, IL, USA, 16-18 Apr 1986)			
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010522	MN -94c	11:32170
CONF-8604117-	(10. U.S. TRIGA user's conference, College Station, TX, USA, 7-9 Apr 1986)			
5	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010503	MN -79	11:31843
CONF-8604136-	(Society of Petroleum Engineers regional meeting, Oakland, CA, USA, 2-4 Apr 1986)			
5	*See* LBL-21112	E 1.99: DE86009908	MN -66b	11:31766
CONF-8604144-	(Spring meeting of the Western States Section of the Combustion Institute, Alberta, Canada, 28-30 Apr 1986)			
5	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010288	MN -90	11:31297
CONF-8604165-	(International conference on heavy ion physics, Rochester, NY, USA, 21-22 Apr 1986)			
1	*See* UCRL-94468	E 1.99: DE86009893	MN -34C	11:33198
CONF-8604167-	(Tokyo meeting on computer graphics, Tokyo, Japan, 22-26 Apr 1986)			
1	*See* UCRL-93581	E 1.99: DE86009721	MN -32	11:33486
CONF-8604168-	(ISPRA course on data uncertainties, sensitivities, consistency, and adjustment, Ispra, Italy, 14-18 Apr 1986)			
1	NTIS, PC A05/MF A01 (GPO Dep.)	E 1.99: DE86009512	MN -32	11:33283
CONF-8604169-	(International consultants meeting on geophysics, Vienna, Austria, 7-9 Apr 1986)			
1	*See* BNL-NCS-37888	E 1.99: DE86009912	MN -34C	11:33094
CONF-8604172-	(19. annual oil shale symposium, Golden, CO, USA, 21-22 Apr 1986)			
1	*See* SAND-85-2749C	E 1.99: DE86010098	MN -91	11:31466
CONF-8604175-	(Fusion Power Associates symposium on fusion energy development: an international effort, Washington, DC, USA, 24-25 Apr 1986)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010035	MN -20	11:33400
CONF-8604177-	(ACM mountain regional conference, Santa Fe, NM, USA, 11-13 Apr 1986)			
1	*See* LA-UR-86-1176	E 1.99: DE86010169	MN -32	11:33472
CONF-8604179-	(HAZPRO '86, Baltimore, MD, USA, 1-3 Apr 1986)			
1	*See* MLM-3353-OP	E 1.99: DE86010416	MN -70	11:31516
CONF-8604182-	(Fusion energy division annual information meeting, Oak Ridge, TN, USA, 8-9 Apr 1986)			
Absts.	*See* ORNL/M-156	E 1.99: DE86009975	MN -20	11:33408
CONF-860507-	(3. workshop on integrity of containments for nuclear power plants, Washington, DC, USA, 21-23 May 1986)			
1	*See* SAND-86-1071C	T186010474	MN -78	11:31958
CONF-860508-	(8. symposium on biotechnology for fuels and chemicals, Gatlinburg, TN, USA, 13-16 May 1986)			
Absts.	*See* ORNL/M-148	E 1.99: DE86010058	MN -61	11:31659
CONF-860522-	(7. international conference on plasma surface interactions in controlled fusion devices, Princeton, NJ, USA, 5-9 May 1986)			
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010400	MN -20d	11:33291
2	*See* SAND-85-2623C	E 1.99: DE86010441	MN -20c	11:33410
CONF-860548-	(8. international symposium on coal slurry fuels preparation and utilization, Orlando, FL, USA, 27-30 May 1986)			
1	*See* DOE/FE/60181-201	E 1.99: DE86010023	MN -90	11:31356
CONF-860551-	(Technical meeting and workshop on fusion reactor design and technology, Yalta, USSR, 26 May-6 Jun 1986)			
2	*See* LA-UR-86-1299	E 1.99: DE86010185	MN -20	11:33405
CONF-860565-	(International conference on optical and millimeter wave propagation and scattering in the atmosphere, Florence, Italy, 27-30 May 1986)			
1	*See* UCRL-93771	E 1.99: DE86006713	MN -11	11:32701
CONF-8605105-	(32. annual Institute of Environmental Sciences technical meeting, Dallas, TX, USA, 6-8 May 1986)			
2	*See* SAND-86-2065C	E 1.99: DE86010100	MN -38	11:32430
CONF-8605108-	(Evolution, games, and learning conference, Los Alamos, NM, USA, 20-24 May 1986)			
1	*See* LA-UR-86-1288	E 1.99: DE86010183	MN -32	11:33473
CONF-8605109-	(3. international symposium on hydrogen produced from renewable energy, Manoa, HI, USA, 22-23 May 1986)			
1	*See* LA-UR-86-1476	E 1.99: DE86010206	MN -96	11:32126
CONF-8605110-	(OPTO '86 conference, Paris, France, 13-15 May 1986)			
1	*See* LA-UR-86-1249	E 1.99: DE86010190	MN -38	11:32422

Report Number	Availability Source	File Number	Distribution Category	Abstract Number
CONF-860604-	(International symposium on the packaging and transport of radioactive materials (PATRAM '86), Davos, Switzerland, 16-20 Jun 1986)			
10	*See* SAND-85-1971C	E 1.99: DE86010480	MN -71	11:32426
11	*See* IAEA-SM-286/230P	E 1.99: DE86010616	MN -71	11:32420
CONF-860605-	(13. international symposium on the effects of radiation on materials, Seattle, WA, USA, 23-25 Jun 1986)			
12	*See* LA-UR-86-934	E 1.99: DE86008736	MN -25	11:32576
CONF-860606-	(Air Pollution Control Association annual meeting and exhibition, Minneapolis, MN, USA, 22-27 Jun 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86008496	MN -41	11:32709
CONF-860608-	(World congress on high tech ceramics: electronic, engineering, nuclear, biomedical research and applications in focus, Milan, Italy, 23-27 Jun 1986)			
1	*See* LA-UR-86-1276	E 1.99: DE86010181	MN -20c	11:32235
CONF-860609-	(27. U.S. symposium on rock mechanics, Tuscaloosa, AL, USA, 23-25 Jun 1986)			
6	*See* LA-UR-86-771	E 1.99: DE86007367	MN -11	11:32521
7	*See* LA-UR-86-785	E 1.99: DE86007365	MN -66b	11:32881
13	*See* UCRL-93412	E 1.99: DE86009719	MN -11	11:32886
14	*See* SAND-85-1937C	E 1.99: DE86010460	MN -38	11:32405
CONF-860610-	(American Nuclear Society annual meeting, Reno, NV, USA, 15-20 Jun 1986)			
4-Rev.1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86005083	MN -34C	11:33095
8	*See* SAND-86-0040C	E 1.99: DE86005628	MN -34	11:33286
17	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86007229	MN -20d	11:33398
18	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86007301	MN -20c	11:32169
CONF-860612-	(4. AIAA/ASME thermophysics and heat transfer conference, Boston, MA, USA, 2-4 Jun 1986)			
1	*See* SERI/TP-252-2847	E 1.99: DE86004430	MN -59B	11:32472
2	*See* SERI/TP-252-2903	E 1.99: DE86004434	MN -62c	11:31734
5	*See* LA-UR-86-1490	E 1.99: DE86010208	MN -38	11:32424
CONF-860616-	(International symposium on intense dynamic loading and its effects, Beijing, China, 3-7 Jun 1986)			
7	*See* SAND-85-2412C	E 1.99: DE86003454	MN -25	11:32237
8	*See* SAND-85-2411C	E 1.99: DE86003502	MN -34A	11:33238
10	*See* LA-UR-86-634	E 1.99: DE86007378	MN -34	11:32943
CONF-860622-	(OSA/IEEE conference on lasers and electro-optics (CLEO '86), San Francisco, CA, USA, 9-13 Jun 1986)			
2	*See* UCRL-93991	E 1.99: DE86006729	MN -37	11:32651
3	*See* SAND-86-0323C	E 1.99: DE86007145	MN -38	11:32512
CONF-860625-	(American Society of Civil Engineers meeting on advancements in aerodynamics, fluid mechanics and hydraulics, Minneapolis, MN, USA, 3-5 Jun 1986)			
1	*See* UCRL-92436	E 1.99: DE86005202	MN -25	11:32970
CONF-860626-	(20. annual conference on trace substances in environmental health, Columbia, MO, USA, 2-5 Jun 1986)			
1	NTIS, PC A02; 3	DE86010033	MN -41	11:32855
CONF-860636-	(15. international symposium on rarefied gas dynamics, Gr Italy, 16-20 Jun 1986)			
1	*See* UC 93788	E 1.99: DE86006705	MN -92	11:32474
CONF-860638-	(American control conference, Seattle, WA, USA, 18-20 Jun 1986)			
1	*See* EGG-M-26585	E 1.99: DE86003228	MN -32	11:33467
CONF-860655-	(American Solar Energy Society annual meeting and 11. national passive solar conference, Boulder, CO, USA, 8-14 Jun 1986)			
1	*See* SAND-86-0289C	E 1.99: DE86009377	MN -62a	11:31732
3	*See* SERI/TP-250-2928	E 1.99: DE86004446	MN -59B	11:31755
5	*See* SAND-86-0295C	E 1.99: DE86009624	MN -62	11:31733
6	*See* SERI/TP-250-2934	E 1.99: DE86004452	MN -59B	11:31756
7	*See* LA-UR-86-1251	DE86010178	MN -59B	11:31752
8	*See* SERI/TP-252-2943	E 1.99: DE86004454	MN -59B	11:31757
9	*See* LA-UR-86-1349	E 1.99: DE86010191	MN -59B	11:31753
CONF-860678-	(Design automation conference, Las Vegas, NV, USA, 29 Jun-2 Jul 1986)			
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86005552	MN -32	11:33465
CONF-860681-	(6. international conference on finite elements in water, Lisbon, Portugal, 1 Jun 1986)			
1	*See* UCRL-94000	E 1.99: DE86007177	MN -32	11:33487
CONF-860682-	(SEM spring conference on experimental mechanics, New Orleans, LA, USA, 8-13 Jun 1986)			
1	*See* DP-MS-85-130	E 1.99: DE86007167	MN -25	11:32174
CONF-860683-	(30. annual meeting of the American Association of Cost Engineers, Chicago, IL, USA, 29 Jun-2 Jul 1986)			
1	*See* GA-A-18269	E 1.99: DE86007296	MN -80	11:31862

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CONF-860695-	(HazMat '86: hazardous materials management conference and exhibition, Atlantic City, NJ, USA, 2-4 Jun 1986)				
2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010059	MN -70	11:31496
CONF-8606105-	(27. annual logging symposium of the Society of Professional Well Log Analysts, Houston, TX, USA, 9-13 Jun 1986)				
1	*See* LA-UR-86-980	E 1.99:	DE86008745	MN -11	11:32655
CONF-8606107-	(International conference on aluminum alloys, Charlottesville, WV, USA, 15-20 Jun 1986)				
1	*See* LBL-21156	E 1.99:	DE86009355	MN -25	11:32198
CONF-8606110-	(IFPS Users Association meeting, San Francisco, CA, USA, 9-13 Jun 1986)				
1	*See* UCRL-94404	E 1.99:	DE86009602	MN -13	11:33460
CONF-8606113-	(Carbon conference, Baden-Baden, F.R. Germany, 30 Jun-4 Jul 1986)				
1	*See* LA-UR-86-1180	E 1.99:	DE86010172	MN -94cc	11:32256
CONF-8606114-	(Ice penetration technology workshop, Monterey, CA, USA, 16-19 Jun 1986)				
1	*See* SAND-86-1027C	E 1.99:	DE86010470	MN -38	11:32429
2	*See* SAND-86-1028C	E 1.99:	DE86010471	MN -38	11:32406
CONF-860739-	(11. international pyrotechnics seminar, Vail, CO, USA, 7-11 Jul 1986)				
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009855	MN -4	11:32684
CRIEPI-					
284066	Central Research Inst. of Electric Power Industry, Tokyo, Japan				11:31775
CSIRO-DG-LS-					
59	Commonwealth Scientific and Industrial Research Organization, Mount Waverly (Australia). Div. of Geomechanics				11:31352
CSNI-					
45	*See* NUREG/CR-1724		TI86002655	MN -80	11:31913
DECOM-					
85/ 1	*See* CEGB-TPRD/B-0651/N85		DE86702027	MN -41	11:31890
DESY-					
85-132	NTIS (US Sales Only), PC A04/MF A01		DE86751746	MN -34D	11:33000
85-135	NTIS (US Sales Only), PC A03/MF A01		DE86751745	MN -34D	11:33047
85-137	NTIS (US Sales Only), PC A02/MF A01		DE86751744	MN -34D	11:33001
85-138	NTIS (US Sales Only), PC A03/MF A01		DE86751743	MN -34D	11:33002
85-139	NTIS (US Sales Only), PC A02/MF A01		DE86751742	MN -28	11:32588
85-140	NTIS (US Sales Only), PC A02/MF A01		DE86751741	MN -28	11:32547
85-141	NTIS (US Sales Only), PC A02/MF A01		DE86751740	MN -34D	11:33048
85-143	NTIS (US Sales Only), PC A03/MF A01		DE86751734	MN -34D	11:33040
85-144	NTIS (US Sales Only), PC A04/MF A01		DE86751735	MN -34D	11:33049
86-002	NTIS (US Sales Only), PC A02/MF A01		DE86751737	MN -34D	11:32981
86-003	NTIS (US Sales Only), PC A02/MF A01		DE86751738	MN -34D	11:33050
86-006	NTIS (US Sales Only), PC A02/MF A01		DE86751739	MN -34D	11:33003
DOE/AL/26034-					
T4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010334	MN -32	11:33466
DOE/BC/10439-					
T1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010598	MN -13	11:33457
DOE/CCU-					
86/ 1	Coal Combust. Utiliz., 86: No. No. 1, 5(15 Jan 1986) (GPO Dep.)	E 1.99:			11:31369
DOE/CE/10093-					
H1	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86010486	STD -63	11:31676
DOE/CE/15239-					
T2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009742	MN -63	11:31677
DOE/CE/15240-					
T2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009827	MN -95d	11:32066
DOE/CE/26530-					
T1	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009594	MN -95e	11:32003
DOE/CE/30750-					
T1	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010407	MN -95d	11:32067
DOE/CE/40738-					
T1	NTIS, PC A07/MF A01 (GPO Dep.)	E 1.99:	DE86010013	STD -95f	11:32097
DOE/CS/20419-					
T1	NTIS, PC A09/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010373	MN -95e	11:31647
DOE/CS/30130-					
T1	NTIS, PC A21/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009073	STD -59A	11:31750
DOE/CS/40420-					
T1	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010582	STD -95f	11:31662
DOE/DP-					
0020	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86005422	MN -70	11:31497
DOE/EI/10464-					
T3	NTIS, PC A02/MF A01 - GPO (GPO Dep.)	E 1.99:	DE86010344	MN -92	11:31406
DOE/EIA-					
0035(86/ 01)	NTIS, PC A07/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86009889	MN -98	11:32018
0109(86/ 02)	NTIS, PC A06/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86009681	MN -98B	11:31407
0202(86/ 2Q)	NTIS, PC A03/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86010274	MN -98	11:31408
0204(86/ 02)	NTIS, PC A03/MF A01 - GPO (GPO Dep.)	E 1.99:	DE86009883	MN -98	11:32006
0205(86/ 1)	NTIS, PC A05/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86010272	MN -98	11:31970
0214(84)	NTIS, PC A20/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86010331	MN -98	11:32027

Report Number	Availability Source	File Number	Distribution Category	Abstract Number
0226(86/ 02)	NTIS, PC A03/MF A01; 1 - GPO (GPO Dep.)	E 1.99: DE86010332	MN -98E	11:32020
0384(85)	NTIS, PC A13/MF A01; 1 - GPO (GPO Dep.)	E 1.99: DE86010432	MN -98	11:32028
0397(85/ 4Q)	NTIS, PC A15/MF A01; 1 - GPO (GPO Dep.)	E 1.99: DE86010534	MN -98E	11:32021
6010275	NTIS, PC A04/MF A01; 1 - GPO (GPO Dep.)	E 1.99: DE86010275	MN -98	11:31409
DOE/ER-				
0046/ 23	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE86010232	STD -20c	11:33401
0243	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86008703	MN -11	11:32856
0262	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86008700	MN -11	11:32776
0263	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86009053	MN -34C	11:32523
0269	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99: DE86010056	MN -13	11:31997
DOE/ER/01715-				
249	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86010213	MN -4	11:32378
DOE/ER/02853-				
28	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010633	MN -34D	11:33177
DOE/ER/03919-				
T1	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86010286	MN -2	11:31880
DOE/ER/10676-				
8	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010295	MN -34A	11:32931
DOE/ER/10715-				
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010327	MN -48	11:32794
DOE/ER/12032-				
05	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010579	MN -34	11:32932
DOE/ER/13106-				
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86007858	MN -48	11:32795
DOE/ER/13116-				
8	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010390	MN -34A	11:32933
DOE/ER/13239-				
1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86007850	MN -38	11:32465
DOE/ER/13278-				
2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010776	MN -48	11:32796
DOE/ER/13282-				
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010585	MN -4	11:32398
DOE/ER/13376-				
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010584	MN -48	11:32797
DOE/ER/30075-				
H1	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99: DE86009189	MN -60	11:31772
DOE/ER/40033-				
108	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010233	MN -28	11:32557
DOE/ER/40036-				
5	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE86010294	MN -34D	11:32982
DOE/ER/40048-				
21-N6	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010451	MN -34B	11:33137
DOE/ER/40142-				
1	NTIS, PC A17/MF A01; 1 (GPO Dep.)	E 1.99: DE85010203	MN -28	11:32589
DOE/ER/40176-				
02	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010366	MN -34D	11:33051
DOE/ER/45094-				
3	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86007857	MN -25	11:32172
DOE/ER/45096-				
T2	NTIS, PC A02; 3	DE86010362	MN -25	11:32173
DOE/ER/45114-				
2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010292	MN -25	11:32246
DOE/ER/45123-				
2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010438	MN -4	11:32247
DOE/ER/45220-				
T1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010107	MN -94cc	11:31966
DOE/ER/53208-				
1	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010580	MN -34A	11:33292
DOE/ER/60006-				
4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010293	MN -90i	11:32711
DOE/ER/60039-				
T2	NTIS, PC A02; 3	DE86010296	MN -48	11:32823
DOE/ER/60069-				
T1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010599	MN -48	11:32798
DOE/ER/60084-				
5	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86010371	MN -48	11:32824
DOE/ER/60110-				
3	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010249	STD -48	11:32843
DOE/ER/60176-				
2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010130	MN -48	11:32825
DOE/ET/34006-				
19	NTIS (US Sales Only), PC A04/MF A01 (GPO Dep.)	E 1.99: DE86009976	STD -78	11:31793
DOE/ET/34215-				
39	NTIS (US Sales Only), E08/MF $8.75; 1 (GPO Dep.)	E 1.99: DE86010422	STD -78	11:31794
DOE/ET/53088-				
1	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86010289	MN -20	11:33293
DOE/EV/10004-				
T3	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010382	MN -48	11:32769
T4	NTIS, PC A02; 3	DE86010384	MN -48	11:32770
T5	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010379	MN -48	11:32771
T6	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010380	MN -48	11:32772

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DOE/EV/10091-2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010133	MN -11	11:32814
DOE/EV/10237-T3	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010367	MN -90a	11:31332
DOE/EV/10244-T5	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010588	MN -4	11:31333
DOE/EV/10359-4	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010375	MN -48	11:32829
6	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010341	MN -48	11:32830
DOE/FE/60181-201	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010023	MN -90	11:31356
DOE/ID/12079-130	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009899	MN -66a	11:31763
131	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009898	MN -66a	11:32878
DOE/IG-0227	USDOE-TIC, PO Bx 62, Oak Ridge, TN 37830		TI86010452	ND -13	11:32005
DOE/JPL-1060-87	NTIS, PC A05/MF A01 (GPO Dep.)	E 1.99:	DE86010240	MN -62	11:31731
DOE/LC/11061-T6	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009294	MN -91	11:31465
DOE/MA-0048/ 4	NTIS, PC A11/MF A01 (GPO Dep.)	E 1.99:	DE86010457	MN -13	11:33491
DOE/MC/19301-2036	NTIS, PC A14/MF A01; 1 (GPO Dep.)	E 1.99:	DE86001073	STD -90c	11:31298
DOE/MC/20212-2039	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010431	STD -93A	11:32033
DOE/MC/20334-T30	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010408	MN -90a	11:32466
DOE/MC/21136-7	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010754	MN -92a	11:31388
DOE/MC/21284-2008	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86001080	MN -93	11:31776
DOE/MC/21290-2007	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86001054	STD -90c	11:31299
DOE/MC/21385-2021	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86001056	STD -90d	11:31300
DOE/METC-86/ 0226	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86001023	STD -90c	11:31301
86/ 0231	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86001038	STD -92a	11:31418
86/ 0233	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86001040	STD -92a	11:31353
86/ 6036-Vol.2	NTIS, PC A14/MF A01; 1 (GPO Dep.)	E 1.99:	DE86001077	STD -90	11:31357
DOE/NBB-0076	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010257	STD -11	11:31981
DOE/NBM-6010458	NTIS, PC A08/MF A01; 1 - GPO (GPO Dep.)	E 1.99:	DE86010458	MN -98C	11:31460
DOE/NE/44139-1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010127	STD -70	11:31498
2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010128	STD -70	11:31499
3	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010129	STD -70	11:31500
4	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010531	STD -70	11:31501
6	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86010532	STD -70	11:31502
7	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010533	STD -70	11:31503
DOE/NV/10270-2-Rev.1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010364	MN -70	11:32879
DOE/NV/10355-1	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009409	MN -66f	11:31765
DOE/OR/20722-98	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009982	MN -11	11:32760
100	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009877	MN -11	11:31603
DOE/OR/21552-1	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009834	MN -11	11:32880
DOE/PC/60054-T10	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010350	MN -90d	11:31309
DOE/PC/60796-10	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010212	MN -90a	11:31334
DOE/PC/60805-T10	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010409	MN -90a	11:31648
DOE/PC/60806-T5	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86010433	MN -90b	11:31362
DOE/PC/60813-11	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99:	DE86010635	MN -90d	11:31310
DOE/PC/70003-T9	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010322	MN -90d	11:31363
DOE/PC/70028-T6	NTIS, PC A13/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010639	MN -90d	11:31649
DOE/PC/70765-8	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010574	MN -90b	11:31364
DOE/PC/71257-T6	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010326	MN -90d	11:31311
DOE/PC/80023-T4	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010447	MN -90d	11:31312
DOE/PC/80261-2Q	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010637	MN -90e	11:31367

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DOE/PC/80512-T4	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86008698	MN -90i	11:31313
DOE/PC/80515-1	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009495	MN -90c	11:31343
DOE/PC/80520-T2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86009838	MN -90i	11:31314
DOE/PC/80523-T2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86009974	MN -90i	11:31344
DOE/PC/80528-T2	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009769	MN -90e	11:31368
DOE/PC/80912-T2	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010361	MN -90d	11:31315
DOE/PC/81201-T2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010610	MN -90a	11:31316
DOE/PE/17056-T10	NTIS, PC A06/MF A01 (GPO Dep.)	E 1.99:	DE86009862	MN -41	11:32510
DOE/RA/35017-T2	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009301	MN -98	11:31764
DOE/RL/01830-H1	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010055	STD -96	11:32118
DOE/RL/10582-3	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010439	MN -70	11:31504
DOE/RW-0047-Vol.1	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010645	STD -70	11:31505
0047-Vol.2	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010646	STD -70	11:31506
DOE/RW/00037-T1	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009654	MN -85	11:31483
T1-App.	NTIS, PC A15/MF A01 (GPO Dep.)	E 1.99:	DE86009655	MN -85	11:31484
DOE/S-0010(85)	NTIS, PC A11/MF A01 (GPO Dep.)	E 1.99:	DE86009652	STD -05	11:31971
DOE/SF/01424-T8	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009767	MN -92	11:31389
DOE/SF/15134-T1	NTIS, PC A11/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009444	MN -66a	11:31762
DOE/TIC-11105	NTIS$17.00				11:31751
DOT-I-85-44	US Dept. of Transportation, Technology Sharing Program, Washington, D.C. 20590		TI86901351	MN -13	11:31972
86-08	US Dept. of Transportation, Technology Sharing Program, Washington, D.C. 20590		TI86901350	MN -13	11:31973
DP-MS-85-130	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86007167	MN -25	11:32174
DPh-N-S-2279	*See* CEA-CONF-7967		DE86751778	MN -34C	11:33100
2294	*See* CEA-CONF-8040		DE86751782	MN -34C	11:33175
2302	*See* CEA-CONF-8145		DE86751779	MN -34C	11:33176
2306	*See* CEA-CONF-8060		DE86751781	MN -34C	11:33124
DPST-85-1-12	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010356	MN -2	11:31886
86-1-2	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010753	MN -2	11:31507
EEB-BED-86-01	*See* LBL-20874	E 1.99:	DE86009927	MN -95d	11:32071
EEB-Vent-84-13	*See* LBL-17598-Rev.	E 1.99:	DE86009367	MN -41	11:32713
EEB-W-85-08	*See* LBL-19550	E 1.99:	DE86009923	MN -95d	11:32069
86-05	*See* LBL-20213	E 1.99:	DE86009924	MN -95d	11:32070
EEO-57/ 75	NTIS (US Sales Only), PC A03/MF A01; 1		DE86751858	MN -95f	11:32099
62/ 94	NTIS (US Sales Only), PC A03/MF A01; 1		DE86751861	MN -95f	11:32100
64/ 116	NTIS (US Sales Only), PC A03/MF A01; 1		DE86751859	MN -95f	11:32101
65/ 28	NTIS (US Sales Only), PC A03/MF A01; 1		DE86751857	MN -95e	11:32102
66/ 115	NTIS (US Sales Only), PC A03/MF A01; 1		DE86751860	MN -95f	11:32103
67/ 136	NTIS (US Sales Only), PC A03/MF A01; 1		DE86751862	MN -95f	11:32104
69/ 85/ 195	NTIS (US Sales Only), PC A05/MF A01; 1		DE86751856	MN -95f	11:32105
EGG-2436	*See* NUREG/CR-4488		TI86010581	MN -78	11:31954
EGG-M-26585	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86003228	MN -32	11:33467
28185	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86005324	MN -80	11:31896
EIR-533	Also published in "J. Nucl. Mater.", September 1984, Vol. 126(1) p. 30-37			ND -25	11:32175
568	NTIS (US Sales Only), PC A03/MF A01		DE86702044	MN -25	11:32176
581	NTIS (US Sales Only), PC A04/MF A01; 1		DE86752029	MN -95	11:32131
ENEA-RT/CHI-82-7	NTIS (US Sales Only), PC A03/MF A01; 1		DE86901374	MN -70	11:32328
ENEA-RT-DISP-82-1	NTIS (US Sales Only), PC A05; 3		DE86901382	MN -78	11:31897
ENEA-RT/FARE-SDI-83-2	NTIS (US Sales Only), PC A05/MF A01; 1		DE86901366	MN -63	11:31694
ENEA-RT/FARE-SIN-81-2	NTIS (US Sales Only), PC A02/MF A01; 1		DE86900989	MN -11	11:32777

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82-3	NTIS (US Sales Only), PC A05/MF A01; 1	DE86901369	MN -22	11:31474
82-8	NTIS (US Sales Only), PC A02/MF A01; 1	DE86901373	MN -20	11:33294
ENEA-RT/ING-				
82-18	NTIS (US Sales Only), PC A02/MF A01; 1	DE86901375	MN -78	11:31898
82-19	NTIS (US Sales Only), PC A03/MF A01; 1	DE86901376	MN -38	11:32418
82-20	NTIS (US Sales Only), PC A02/MF A01; 1	DE86901377	MN -83	11:33214
82-22	NTIS (US Sales Only), PC A02/MF A01; 1	DE86901379	MN -78	11:31899
82-24	NTIS (US Sales Only), PC A03/MF A01	DE86901380	MN -79p	11:31863
ENEA-RT-PAS-				
85/ 22	NTIS (US Sales Only), PC A02/MF A01	DE86901293	MN -41	11:32844
EPA/520/5-				
85/ 032	*See* PB-86-158011/XAB			11:32744
EPA/600/8-				
84/ 020B-1	*See* PB-86-155645/XAB			11:32718
84/ 020B-5	*See* PB-86-155652/XAB			11:32719
EPRI-AP-				
4536	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920266	ND -90a	11:31335
EPRI-CS-				
4322	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920268	ND -90	11:31962
4386	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920270	ND -89	11:31779
4433	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920269	ND -90	11:31365
4515	Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303	TI86920271	ND -90h	11:32177
4546	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920267	ND -90i	11:32178
4547	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920274	ND -90	11:31366
4562	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920272	ND -90h	11:32179
EPRI-EA-				
4490	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920255	ND -41	11:31376
EPRI-EM-				
3868-Vol.2	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920276	ND -95f	11:32106
4508	Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303	TI86920275	ND -95f	11:32180
4511-Vol.1	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920278	ND -93A	11:32022
4511-Vol.2	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920279	ND -93A	11:32023
4519-Vol.1	Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303	TI86920246	ND -98G	11:31998
4527	Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303	TI86920277	ND -95f	11:32024
EPRI-NP-				
4353-SR	Research Reports Center Box 50490, Palo Alto, CA 94303.	TI86920258	ND -78	11:31900
4514-SR-LD	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920261	ND -2	11:31795
4521	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920260	ND -78	11:31806
4524	NTIS, PC A05/MF A01 - Research Reports Center, Box 50490, Palo Alto, CA 94303; 1 (GPO Dep.)	E 1.99: DE86010873	MN -78	11:31796
4529	Research Reports Center, Box 50490, Palo Alto, CA 94303	TI86920259	ND -78	11:31807
4530	Research Reports Center P.O. Box 50490 Palo Alto, CA 94303	TI86920257	ND -78	11:31808
4560	Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303	TI86920262	ND -78	11:31797
4561	NTIS (US Sales Only), PC A05/MF A01; 1 - Research Reports Center, Box 50490, Palo Alto, CA 94303 (GPO Dep.)	E 1.99: DE86010593	MN -78	11:31809
ESL-				
86006-TR	*See* DOE/ID/12079-130	E 1.99: DE86009899	MN -66a	11:31763
86007-TR	*See* DOE/ID/12079-131	E 1.99: DE86009898	MN -66a	11:32878
ETSU-N-				
3/ 85	H.M. Stationery Office, London, price Pound 7		ND -13	11:31990
ETSU-R-				
28	H.M. Stationery Office, London, price Pound 6		ND -13	11:31991
EUR-				
9475-FR	European Community Information Service, 2100 M St., NW, Suite 707, Washington, DC 20057			11:32019
9571	NTIS (US Sales Only), PC A02/MF A01	DE86751797	MN -70	11:31508
9667	NTIS (US Sales Only), PC A05/MF A01	DE86751795	MN -70	11:31509
9675	NTIS (US Sales Only), PC A08/MF A01	DE86751796	MN -11	11:32741
9976-FR	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -63	11:31695

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9990-EN	European Community Information Service, 2100 M St., NW, Suite 707, Washington, DC 20037			11:31697
10013-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -61A	11:31698
10058	NTIS (US Sales Only), PC A05/MF A01	DE86751799	MN -70	11:31510
10061	NTIS (US Sales Only), PC A10/MF A01	DE86751798	MN -70	11:31511
10068-EN	European Community Information Service, 2100 M St., NW, Suite 707, Washington, DC 20057			11:31317
10091-EN	European Community Information Service, 2100 M St., NW, Suite 707, Washington, DC 20057			11:31318
10108-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -61	11:31699
10302-EN	Commission of the European Communities, Luxembourg. Office of Official Publications of the European Communities		ND -61	11:31650
EUR-CEA-FC-				
1273	NTIS (US Sales Only), PC A10/MF A01	DE86751592	MN -20g	11:33295
1278	NTIS (US Sales Only), PC A03/MF A01	DE86751802	MN -20a	11:33296
1279	NTIS (US Sales Only), PC A03/MF A01	DE86751801	MN -20a	11:33297
FE-				
1207-69(Vol.1)	NTIS			11:31319
1207-69(Vol.2)	NTIS			11:31320
FEI-				
1459	NTIS (US Sales Only), PC A03/MF A01	DE86702081	MN -37	11:32646
1564	NTIS (US Sales Only), PC A02/MF A01	DE86701992	MN -34C	11:33165
1566	NTIS (US Sales Only), PC A02/MF A01	DE86701975	MN -34C	11:33180
1567	NTIS (US Sales Only), PC A02/MF A01	DE86701976	MN -34C	11:33181
1568	NTIS (US Sales Only), PC A02/MF A01	DE86701977	MN -34C	11:33182
1604	NTIS (US Sales Only), PC A02/MF A01	DE86702077	MN -37	11:32602
FNAL/Pub-				
86/ 51-A	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86009991	MN -34B	11:32915
FNAL-TM-				
1395	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010594	STD -34D	11:32590
1396	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010595	STD -34D	11:32983
FRNC-TH-				
2102	NTIS (US Sales Only), PC A08/MF A01	DE86751785	MN -34A	11:32934
2117	NTIS (US Sales Only), PC A08/MF A01	DE86751791	MN -34A	11:32935
2118	NTIS (US Sales Only), PC A07/MF A01	DE86751788	MN -20a	11:33298
2119	NTIS (US Sales Only), PC A07/MF A01	DE86751787	MN -34A	11:32936
2121	NTIS (US Sales Only), PC A07/MF A01	DE86751784	MN -34A	11:32937
2123	NTIS (US Sales Only), PC A09/MF A01	DE86751793	MN -20a	11:33299
2124	NTIS (US Sales Only), PC A06/MF A01	DE86751790	MN -20a	11:33300
2126	NTIS (US Sales Only), PC A09/MF A01	DE86751789	MN -20a	11:33301
2130	NTIS (US Sales Only), PC A11/MF A01	DE86751792	MN -34B	11:32916
2159	NTIS (US Sales Only), PC A17/MF A01	DE86751794	MN -20a	11:33302
2229	NTIS (US Sales Only), PC A08/MF A01; 1	DE86752158	MN -25	11:32451
2230	NTIS (US Sales Only), PC A09/MF A01; 1	DE86752159	MN -38	11:32419
2239	NTIS (US Sales Only), PC A11/MF A01	DE86751776	MN -86	11:31479
2252	NTIS (US Sales Only), PC A06/MF A01	DE86751780	MN -4	11:32393
2269	NTIS (US Sales Only), PC A13/MF A01; 1	DE86752157	MN -38	11:32229
FSRN-NC-				
333	*See* PB-86-154424/XAB			11:32782
FTD-ID(RS)T-				
1218-85	*See* AD-A-164320/4/XAB			11:32032
FWS/OBS-				
80/ 40.18	NTIS, PC A06/MF A01	TI86901100	MN -11	11:32778
GA-A-				
18269	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86007296	MN -80	11:31862
18341	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010669	STD -20f	11:33402
GANIL-P-				
85-10	NTIS (US Sales Only), PC A02/MF A01	DE86751807	MN -34C	11:33132
GAO/NSIAD-				
86-28BR	General Accounting Office, P.O. Box 6015, Gaithersburg, MD 20877	TI86901162	MN -11	11:32790
GAO/RCED-				
86-47FS	US General Accounting Office Box 6015, Gaithersburg, MD 20877	TI86901163	MN -11	11:31974
86-65-FS	US General Accounting Office, Box 6015, Gaithersburg, MD 20877	TI86901213	MN -69	11:31982
86-70-FS	US General Accounting Office, Box 6015, Gaithersburg, MD 20877 (GPO Dep.)	E 1.99: TI86901214	MN -11	11:31983
GEPP-TIS-				
961	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010265	MN -13	11:33468
GKSS-				
85/ E/ 42	NTIS (US Sales Only), PC A07/MF A01; 1	DE86752030	MN -60	11:31773
85/ E/ 52	NTIS (US Sales Only), PC A02/MF A01; 1	DE86752027	MN -38	11:32522
85/ E/ 55	NTIS (US Sales Only), PC A03/MF A01; 1	DE86752031	MN -4	11:32329
85/ E/ 56	NTIS (US Sales Only), PC A06/MF A01; 1	DE86752026	MN -11	11:32773
GPO-				
5-472	US Capitol, House Document Room			11:32755
GSF-				
38/ 85	NTIS (US Sales Only), PC A16/MF A01	DE86751730	MN -80	11:31901

Report Number	Availability Source	File Number	Distribution Category	Abstract Number
GSF-S-				
1270	*See* GSF-38/85	DE86751730	MN -80	11:31901
GSI-				
86-4-Prepr.	NTIS (US Sales Only), PC A02/MF A01	DE86751761	MN -34C	11:33183
HD-PY-				
86/ 01	NTIS (US Sales Only), PC A03/MF A01	DE86751759	MN -34D	11:32984
HMI-B-				
417	NTIS (US Sales Only), PC A04/MF A01	DE86751727	MN -4	11:32384
HNEI-				
6901192	NTIS, PC A04/MF A01; 1	DE86901192	MN -98D	11:31992
HW-				
49008	NTIS, PC A02; 3	DE86010091	MN -11	11:31583
49465	NTIS, PC A02; 3	DE86010089	MN -70	11:31584
IAE-				
3855/ 6	NTIS (US Sales Only), PC A02/MF A01	DE86701928	MN -34A	11:32938
3862/ 2	NTIS (US Sales Only), PC A02/MF A01	DE86701993	MN -34C	11:33166
3866/ 7	NTIS (US Sales Only), PC A03/MF A01	DE86701946	MN -20	11:33303
3907/ 6	NTIS (US Sales Only), PC A02/MF A01	DE86701944	MN -20	11:33304
3936/ 6	NTIS (US Sales Only), PC A02/MF A01	DE86701929	MN -34A	11:32939
3938/ 9	NTIS (US Sales Only), PC A03/MF A01	DE86701940	MN -34A	11:33215
3947/ 14	NTIS (US Sales Only), PC A02/MF A01	DE86701947	MN -20	11:33305
3961/ 8	NTIS (US Sales Only), PC A02/MF A01	DE86701950	MN -20	11:33306
3979/ 6	NTIS (US Sales Only), PC A02/MF A01	DE86701943	MN -20	11:33307
3996/ 4	NTIS (US Sales Only), PC A02/MF A01	DE86702069	MN -79	11:31844
3997/ 4	NTIS (US Sales Only), PC A02/MF A01	DE86702070	MN -79	11:31845
4003/ 4	NTIS (US Sales Only), PC A02/MF A01	DE86702072	MN -80	11:31881
4012/ 2	NTIS (US Sales Only), PC A02/MF A01	DE86701978	MN -34C	11:33150
4019/ 11	NTIS (US Sales Only), PC A03/MF A01	DE86701941	MN -34A	11:33216
4020/ 11	NTIS (US Sales Only), PC A02/MF A01	DE86702015	MN -25	11:32181
4024/ 14	NTIS (US Sales Only), PC A02/MF A01	DE86702042	MN -28	11:32574
4026/ 8	NTIS (US Sales Only), PC A03/MF A01	DE86701952	MN -20	11:33403
4038/ 6	NTIS (US Sales Only), PC A02/MF A01	DE86701956	MN -93	11:32031
4042/ 7	NTIS (US Sales Only), PC A03/MF A01	DE86701948	MN -20	11:33308
IAEA-SM-				
286-117	*See* SAND-85-1971C	E 1.99: DE86010480	MN -71	11:32426
286/ 230P	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010616	MN -71	11:32420
IAEA-TECDOC-				
352	NTIS (US Sales Only), PC A11/MF A01	DE86780461	MN -83	11:31476
356	NTIS (US Sales Only), PC A10/MF A01	DE86702053	MN -78	11:31799
IEA/ICTIS/TR-				
30	NTIS (US Sales Only), PC A08/MF A01	TI86901136	MN -90i	11:32712
IFVE-OEF-				
85-91	NTIS (US Sales Only), PC A02/MF A01	DE86702078	MN -37	11:32603
IIUG/dp-				
84-14	NTIS (US Sales Only), PC A03/MF A01; 1	DE86752019	MN -11	11:31984
85-1	NTIS (US Sales Only), PC A03/MF A01; 1	DE86752024	MN -11	11:31985
INDC(FR)-				
64/ L	*See* NEANDC(E)-231/L	DE86901284	MN -34C	11:33474
INIS-BR-				
457	NTIS (US Sales Only), PC A08/MF A01	DE86702050	MN -80	11:31902
458	NTIS (US Sales Only), PC A06/MF A01	DE86702046	MN -80	11:31866
459	NTIS (US Sales Only), PC A11/MF A01	DE86702051	MN -80	11:31870
460	NTIS (US Sales Only), PC A02/MF A01	DE86702010	MN -25	11:32182
461	NTIS (US Sales Only), PC A05/MF A01	DE86702106	MN -2	11:31993
462	NTIS (US Sales Only), PC A17/MF A01	DE86702009	MN -25	11:32230
463	NTIS (US Sales Only), PC A05/MF A01	DE86701937	MN -34A	11:32254
464	NTIS (US Sales Only), PC A08/MF A01	DE86701951	MN -20	11:33309
465	NTIS (US Sales Only), PC A04/MF A01	DE86701933	MN -34A	11:32233
466	NTIS (US Sales Only), PC A05/MF A01	DE86702063	MN -78	11:31810
467	NTIS (US Sales Only), PC A02/MF A01	DE86702100	MN -2	11:31609
468	NTIS (US Sales Only), PC A02/MF A01	DE86702085	MN -2	11:31811
469	NTIS (US Sales Only), PC A02/MF A01	DE86702064	MN -78	11:31812
INIS-mf-				
9874	NTIS (US Sales Only), PC A13/MF A01	DE86701967	MN -34D	11:32985
9878	NTIS (US Sales Only), PC A02/MF A01	DE86751755	MN -34D	11:33004
9879	NTIS (US Sales Only), PC A06/MF A01	DE86751747	MN -11	11:32779
9880	NTIS (US Sales Only), PC A08/MF A01	DE86751750	MN -48	11:32831
9882	NTIS (US Sales Only), PC A03/MF A01	DE86751757	MN -34D	11:33052
10090	NTIS (US Sales Only), PC A05/MF A01	DE86702206	MN -2	11:31999
10093	NTIS (US Sales Only), PC A02/MF A01	DE86702094	MN -2	11:31485
10108	NTIS (US Sales Only), PC A10/MF A01	DE86702086	MN -2	11:31994
10109	NTIS (US Sales Only), PC A11/MF A01	DE86702065	MN -78	11:31813
10110	NTIS (US Sales Only), PC A04/MF A01	DE86701972	MN -34C	11:33218
10111	NTIS (US Sales Only), PC A03/MF A01	DE86701997	MN -4	11:32330
10121	NTIS (US Sales Only), PC A03/MF A01	DE86702029	MN -41	11:33230
10122	NTIS (US Sales Only), PC A07/MF A01	DE86702030	MN -41	11:33231
10123	NTIS (US Sales Only), PC A02/MF A01	DE86702087	MN -2	11:31615
10124	NTIS (US Sales Only), PC A02/MF A01	DE86702095	MN -2	11:31486
10125	NTIS (US Sales Only), PC A02/MF A01	DE86702092	MN -2	11:32000
10126	NTIS (US Sales Only), PC A02/MF A01	DE86702096	MN -2	11:31906
10127	NTIS (US Sales Only), PC A02/MF A01	DE86702097	MN -2	11:31907
10128	NTIS (US Sales Only), PC A02/MF A01	DE86702093	MN -2	11:32832
10129	NTIS (US Sales Only), PC A02/MF A01	DE86702098	MN -2	11:32833
10130	NTIS (US Sales Only), PC A02/MF A01	DE86702088	MN -2	11:31616

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10131	NTIS (US Sales Only), PC A02/MF A01	DE86702089	MN -2	11:31617
10132	NTIS (US Sales Only), PC A02/MF A01	DE86702090	MN -2	11:31618
10134	NTIS (US Sales Only), PC A02/MF A01	DE86702099	MN -2	11:31610
INIS-SU-				
320	NTIS (US Sales Only), PC A16/MF A01	DE86780457	MN -34D	11:32976
321	NTIS (US Sales Only), PC A19/MF A01	DE86780458	MN -34D	11:32977
324	NTIS (US Sales Only), PC A03/MF A01	DE86780460	MN -34D	11:32978
325	NTIS (US Sales Only), PC A04/MF A01	DE86780459	MN -34D	11:32979
INP-				
1172/ PH	NTIS (US Sales Only), PC A05/MF A01	DE86701958	MN -34D	11:33020
1173/ PH	NTIS (US Sales Only), PC A02/MF A01	DE86701979	MN -34C	11:33187
1178/ PH	NTIS (US Sales Only), PC A02/MF A01	DE86701959	MN -34D	11:33064
1191/ PL	NTIS (US Sales Only), PC A04/MF A01	DE86701991	MN -34C	11:33114
1193/ PL	NTIS (US Sales Only), PC A03/MF A01	DE86701986	MN -34C	11:33188
INS-P-				
163	NTIS (US Sales Only), PC A02/MF A01	DE86702205	MN -32	11:33469
IOS-Rep-				
213	NTIS (US Sales Only), PC A05/MF A01	DE86702084	MN -70	11:31513
IPEN-Pub-				
66	NTIS (US Sales Only), PC A03/MF A01	DE86702019	MN -11	11:31585
67	NTIS (US Sales Only), PC A02/MF A01	DE86702004	MN -4	11:32331
69	NTIS (US Sales Only), PC A07/MF A01	DE86702016	MN -51	11:31471
70	NTIS (US Sales Only), PC A02/MF A01	DE86701998	MN -4	11:31611
71	NTIS (US Sales Only), PC A02/MF A01	DE86702003	MN -4	11:32394
72	NTIS (US Sales Only), PC A02/MF A01	DE86702102	MN -32	11:33470
73	NTIS (US Sales Only), PC A02/MF A01	DE86702103	MN -32	11:31828
74	NTIS (US Sales Only), PC A02/MF A01	DE86701999	MN -4	11:32332
75	NTIS (US Sales Only), PC A02/MF A01	DE86702000	MN -4	11:32333
79	NTIS (US Sales Only), PC A02/MF A01	DE86702006	MN -4	11:32334
80	NTIS (US Sales Only), PC A02/MF A01	DE86702076	MN -37	11:32604
81	NTIS (US Sales Only), PC A02/MF A01	DE86702021	MN -23	11:32841
82	NTIS (US Sales Only), PC A02/MF A01	DE86702073	MN -80	11:31882
83	NTIS (US Sales Only), PC A02/MF A01	DE86701994	MN -34C	11:33167
85	NTIS (US Sales Only), PC A02/MF A01	DE86702104	MN -32	11:31829
IPNO-DRE-				
84-24	NTIS (US Sales Only), PC A02/MF A01	DE86751810	MN -70	11:31514
85-10	NTIS (US Sales Only), PC A03/MF A01	DE86751805	MN -34D	11:33256
IPNO-TH-				
85-11	NTIS (US Sales Only), PC A02/MF A01	DE86751804	MN -34D	11:33257
IPP-				
1/ 236	NTIS (US Sales Only), PC A04/MF A01	DE86751760	MN -20d	11:33404
ISN-				
85-11	NTIS (US Sales Only), PC A02/MF A01	DE86751808	MN -34C	11:33135
85-12	NTIS (US Sales Only), PC A02/MF A01	DE86751809	MN -34C	11:33122
ISPO-				
248	*See* LA-10695-MS	E 1.99: DE86008807	STD -15	11:31612
ITEF-				
13(1985)	NTIS (US Sales Only), PC A02/MF A01	DE86702079	MN -37	11:32605
24(1984)	NTIS (US Sales Only), PC A02/MF A01	DE86701968	MN -34D	11:32986
51(1984)	NTIS (US Sales Only), PC A03/MF A01	DE86701960	MN -34D	11:33021
62(1985)	NTIS (US Sales Only), PC A03/MF A01	DE86702074	MN -80	11:31883
63(1985)	NTIS (US Sales Only), PC A02/MF A01	DE86702075	MN -80	11:31884
175(1984)	NTIS (US Sales Only), PC A02/MF A01	DE86702040	MN -28	11:32549
177(1984)	NTIS (US Sales Only), PC A02/MF A01	DE86701990	MN -34C	11:33102
178(1984)	NTIS (US Sales Only), PC A03/MF A01	DE86702043	MN -28	11:32575
190(1984)	NTIS (US Sales Only), PC A02/MF A01	DE86701987	MN -34C	11:33099
193(1984)	NTIS (US Sales Only), PC A02/MF A01	DE86702041	MN -28	11:32550
ITEP-				
8(1985)	NTIS (US Sales Only), PC A02/MF A01	DE86701922	MN -34D	11:33065
31(1985)	NTIS (US Sales Only), PC A03/MF A01	DE86701926	MN -34D	11:33066
118(1984)	NTIS (US Sales Only), PC A02/MF A01	DE86701961	MN -34D	11:33022
123(1984)	NTIS (US Sales Only), PC A02/MF A01	DE86701980	MN -34C	11:33133
167(1984)	NTIS (US Sales Only), PC A02/MF A01	DE86701925	MN -34D	11:33067
192(1983)	NTIS (US Sales Only), PC A02/MF A01	DE86701988	MN -34C	11:33189
ITP-				
85-8-E	NTIS (US Sales Only), PC A02/MF A01	DE86701981	MN -34C	11:33190
JA-				
5702	*See* AD-A-164091/1/XAB			11:32591
5766	*See* AD-A-164116/6/XAB			11:32440
JET-R-				
84-01	NTIS (US Sales Only), PC A03/MF A01	DE86701949	MN -20	11:33310
JINR-				
1-84-185	NTIS (US Sales Only), PC A02/MF A01	DE86701974	MN -34C	11:33191
1-84-240	NTIS (US Sales Only), PC A02/MF A01	DE86701989	MN -34C	11:33192
D-1-85-166	NTIS (US Sales Only), PC A02/MF A01	DE86702080	MN -37	11:32606
E-1-84-263	NTIS (US Sales Only), PC A02/MF A01	DE86701969	MN -34D	11:32987
E-2-85-203	NTIS (US Sales Only), PC A02/MF A01	DE86701962	MN -34D	11:33068
E-4-85-311	NTIS (US Sales Only), PC A02/MF A01	DE86701982	MN -34C	11:33115
E-19-85-385	NTIS (US Sales Only), PC A02/MF A01	DE86702020	MN -48	11:32845
R-1-85-184	NTIS (US Sales Only), PC A02/MF A01	DE86701970	MN -34D	11:32988
R-2-84-603	NTIS (US Sales Only), PC A02/MF A01	DE86701963	MN -34D	11:33069
R-2-85-124	NTIS (US Sales Only), PC A02/MF A01	DE86701983	MN -34C	11:33168
R-2-85-198	NTIS (US Sales Only), PC A02/MF A01	DE86701964	MN -34D	11:33023
R-4-84-693	NTIS (US Sales Only), PC A02/MF A01	DE86701927	MN -34A	11:32940

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R-4-85-319	NTIS (US Sales Only), PC A02/MF A01		DE86701973	MN -34C	11:33116
R-7-85-267	NTIS (US Sales Only), PC A02/MF A01		DE86701995	MN -34C	11:33169
R-14-84-273	NTIS (US Sales Only), PC A02/MF A01		DE86701930	MN -34A	11:32941
R-14-84-429	NTIS (US Sales Only), PC A02/MF A01		DE86701942	MN -34A	11:33220
R-14-84-571	NTIS (US Sales Only), PC A02/MF A01		DE86701931	MN -34A	11:32942
R-14-85-2	NTIS (US Sales Only), PC A02/MF A01		DE86701938	MN -34A	11:32255
R-17-84-371	NTIS (US Sales Only), PC A02/MF A01		DE86701932	MN -34A	11:33221
JPL-PUB-					
85-52	*See* DOE/JPL-1060-87	E 1.99:	DE86010240	MN -62	11:31731
Juel-					
1975	NTIS (US Sales Only), PC A07/MF A01; 1		DE86752020	MN -25	11:32194
2014	NTIS (US Sales Only), PC A05/MF A01		DE86751748	MN -48	11:32846
Juel-Spez-					
292	NTIS (US Sales Only), PC A11/MF A01		DE86751728	MN -98	11:31977
329	NTIS (US Sales Only), PC A03/MF A01; 1		DE86752023	MN -11	11:32691
K/CSD/TM-					
59	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86010348	MN -95c	11:32068
K/ET-					
5021	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009958	MN -12	11:31989
K/P-					
6197-Rev.1	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009328	MN -41	11:31604
K/TS-					
11780	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010615	MN -38	11:32421
KAPL-					
4192	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010353	STD -25	11:32195
KFK-					
3988-B	NTIS (US Sales Only), PC A02/MF A01		DE86751753	MN -37	11:32607
4001	NTIS (US Sales Only), PC A08/MF A01		DE86751729	MN -48	11:32847
4002	NTIS (US Sales Only), PC A10/MF A01		DE86751751	MN -80	11:31908
4007	NTIS (US Sales Only), PC A04/MF A01		DE86751754	MN -34C	11:33193
4009	NTIS (US Sales Only), PC A10/MF A01; 1		DE86752022	MN -25	11:32234
4015	NTIS (US Sales Only), PC A03/MF A01		DE86751749	MN -41	11:32511
4035	NTIS (US Sales Only), PC A03/MF A01; 1		DE86901358	MN -34D	11:32989
KIYI-					
83-34	NTIS (US Sales Only), PC A02/MF A01		DE86780377	MN -23	11:33096
LA-					
10575-MS	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99:	DE86007861	STD -70B	11:31586
10605-MS	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86009790	STD -11	11:32742
10651	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86008028	STD -32	11:33462
10669-MS	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86008161	STD -34B	11:32917
10678-M	*See* NUREG/CR-4561		TI86010227	MN -41	11:31606
10689-PR	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009799	STD -34C	11:33194
10695-MS	NTIS, PC A07/MF A01; 1 (GPO Dep.)	E 1.99:	DE86008807	STD -15	11:31612
10708-T	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99:	DE86008225	STD -25	11:32196
10719-SR	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86008019	STD -28	11:32532
LA-tr-					
86-9	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010349	MN -4	11:32366
86-11	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010271	MN -4	11:32365
86-12	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010347	MN -4	11:32364
86-22	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010771	MN -38	11:32460
LA-UR-					
86-634	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86007378	MN -34	11:32943
86-771	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86007367	MN -11	11:32521
86-785	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86007365	MN -66b	11:32881
86-934	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86008736	MN -25	11:32576
86-980	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86008745	MN -11	11:32655
86-1116	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86010161	MN -34D	11:33070
86-1149	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010163	MN -48	11:32799
86-1151	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010164	MN -32	11:33471
86-1156	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010165	MN -20c	11:32197
86-1175	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010168	MN -34C	11:33195
86-1176	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010169	MN -32	11:33472
86-1180	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010172	MN -94cc	11:32256
86-1238	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010177	MN -34D	11:33258
86-1249	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010190	MN -38	11:32422
86-1251	NTIS, PC A02; 3		DE86010178	MN -59B	11:31752
86-1262	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010179	MN -34D	11:33259
86-1276	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010181	MN -20c	11:32235
86-1288	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010183	MN -32	11:33473
86-1298	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010184	MN -38	11:32423
86-1299	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010185	MN -20	11:33405
86-1306	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010186	MN -34D	11:33071
86-1333	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010189	MN -34D	11:33072
86-1349	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010191	MN -59B	11:31753
86-1363	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010192	MN -38	11:32403
86-1476	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010206	MN -96	11:32126
86-1490	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86010208	MN -38	11:32424
86-1492	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99:	DE86010209	MN -34D	11:33073
LBL-					
17598-Rev.	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86009367	MN -41	11:32713
19550	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009923	MN -95d	11:32069
20213	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009924	MN -95d	11:32070
20833-Rev.	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009906	MN -28	11:33260
20835-Rev.	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99:	DE86009905	MN -28	11:33261

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20874	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009927	MN -95d	11:32071
21104	NTIS, PC A09/MF A01; 1 (GPO Dep.)	E 1.99: DE86010401	MN -4	11:32368
21112	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009908	MN -66b	11:31766
21156	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009355	MN -25	11:32198
21249	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009950	MN -66a	11:31767
21272	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009357	MN -34C	11:33196
LBL-PUB-				
496-4-86	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86009955	MN -28	11:32539
LCC-				
004/ 85	NTIS (US Sales Only), PC A02/MF A01	DE86702047	MN -80	11:31867
021/ 85	NTIS (US Sales Only), PC A02/MF A01	DE86702033	MN -38	11:32467
022/ 85	NTIS (US Sales Only), PC A02/MF A01	DE86702034	MN -38	11:32468
023/ 85	NTIS (US Sales Only), PC A02/MF A01	DE86702035	MN -38	11:32469
032/ 85	NTIS (US Sales Only), PC A02/MF A01	DE86701918	MN -34D	11:33262
LP-				
202	NTIS (US Sales Only), PC A05/MF A01	DE86751786	MN -20	11:32944
MINTEK-M-				
103D	NTIS (US Sales Only), PC A03/MF A01	DE86702005	MN -4	11:32335
204	NTIS (US Sales Only), PC A03/MF A01	DE86702007	MN -86	11:31473
205	NTIS (US Sales Only), PC A03/MF A01	DE86702002	MN -4	11:32336
MLM-				
3350(OP)	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010413	MN -25	11:32152
3351-OP	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010414	MN -70B	11:31515
3353-OP	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010416	MN -70	11:31516
MPI-PAE/Exp.El.-				
157	NTIS (US Sales Only), PC A02/MF A01	DE86751758	MN -34D	11:33024
MPQ-				
97	NTIS (US Sales Only), PC A02/MF A01	DE86752018	MN -34C	11:33222
MS-				
6647A	*See* AD-A-164115/8/XAB			11:32439
MSHA/IR-				
1170	*See* PB-86-161577/XAB			11:31383
1175	*See* PB-86-160801/XAB			11:31382
MZ-TH-				
85-19	*See* DESY-85-143	DE86751734	MN -34D	11:33040
NAA-SR-				
8026	North American Aviation, Inc., Downey, CA	TI86901304	MN -38	11:32470
NBS/TN-				
1218	*See* PB-86-168267/XAB			11:32078
NE/TORV-				
80/ 1	NTIS			11:31651
NEANDC(E)-				
231/ L	NTIS (US Sales Only), PC A07/MF A01; 1	DE86901284	MN -34C	11:33474
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76	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86000281	STD -92a	11:31390
97	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010799	MN -92a	11:31391
108	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE86010657	MN -92b	11:31336
118	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86010798	MN -92a	11:31392
145	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010800	MN -92	11:31393
151	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86010603	MN -92b	11:32132
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84/ 33-Prepr.	NTIS (US Sales Only), PC A02/MF A01	DE86751765	MN -34A	11:33236
84/ 34-Prepr.	NTIS (US Sales Only), PC A04/MF A01	DE86751767	MN -34B	11:32919
84/ 36-Prepr.	NTIS (US Sales Only), PC A02/MF A01	DE86751762	MN -34B	11:32920
84/ 37-Prepr.	NTIS (US Sales Only), PC A03/MF A01	DE86751763	MN -34B	11:32921
84/ 40-Prepr.	NTIS (US Sales Only), PC A04/MF A01	DE86751764	MN -25	11:33237
84/ 42-Prepr.	NTIS (US Sales Only), PC A03/MF A01	DE86751766	MN -34A	11:33246
NOSC/TR-				
1062	*See* AD-A-164161/2/XAB			11:32775
NP-				
6751997	NTIS (US Sales Only), PC A02/MF A01; 1	DE86751997	MN -98	11:32007
6752007	NTIS (US Sales Only), PC A02/MF A01; 1	DE86752007	MN -98	11:31976
6752008	NTIS (US Sales Only), PC A02/MF A01; 1	DE86752008	MN -98	11:32008
6752009	NTIS (US Sales Only), PC A02/MF A01; 1	DE86752009	MN -98	11:32009
6752010	NTIS (US Sales Only), PC A03/MF A01; 1	DE86752010	MN -98	11:32010
6752015	NTIS (US Sales Only), PC A02/MF A01	DE86752015	MN -98	11:32011
6752016	NTIS (US Sales Only), PC A02/MF A01; 1	DE86752016	MN -98	11:32012
6752017	NTIS (US Sales Only), PC A02/MF A01; 1	DE86752017	MN -98	11:32013
6752021	NTIS (US Sales Only), PC A03/MF A01; 1	DE86752021	MN -98	11:32014
6752025	NTIS (US Sales Only), PC A07/MF A01; 1	DE86752025	MN -38	11:32471
6752028	NTIS (US Sales Only), PC A02/MF A01; 1	DE86752028	MN -98	11:32015
6752032	NTIS (US Sales Only), PC A09/MF A01; 1	DE86752032	MN -98	11:31978
6901349	NTIS (US Sales Only), PC A05/MF A01; 1	DE86901349	MN -61	11:31700
NPRU-				
81/ 18	Nuclear Physics Research Unit, University of the Witwatersrand, 1 Jan Smuts Avenue, Johannesburg, 2001, South Africa		ND -48	11:32834
NPS-				
67-85-012CR	*See* AD-A-164292/5/XAB			11:32516
NRL-MR-				
5675	*See* AD-A-164166/1/XAB			11:32441
5678	*See* AD-A-164167/9/XAB			11:32442
NRRI-				
86-5	NRRI, 1080 Carmack Road, Columbus, OH 43210	TI86901365	MN -92	11:31461

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NUCLEBRAS-CDTN-				
491	NTIS (US Sales Only), PC A02/MF A01	DE86702066	MN -78	11:31830
497	NTIS (US Sales Only), PC A03/MF A01	DE86702067	MN -78	11:31831
NUREG-				
0020-Vol.10-No.2	NTIS, PC A19/MF A01 - GPO	TI86901169	MN -80	11:31803
0675-Suppl.33	NTIS, PC A20/MF A01 - GPO	TI86901403	MN -78	11:31909
0750-Vol.23-No.2	NTIS, PC A04/MF A01 - GPO	TI86901241	MN -80	11:31859
0857-Suppl.10	NTIS, PC A03/MF A01 - GPO	TI86901308	MN -78	11:31910
0900-Rev.1	NTIS, PC A07/MF A01 - GPO	TI86901240	MN -80	11:31911
1038-Suppl.3	NTIS, PC A07/MF A01 - GPO	TI86901360	MN -78	11:31912
1156	NTIS, PC A06/MF A01 - GPO	TI86901352	MN -41	11:32337
1160	NTIS, PC A03/MF A01 - GPO	TI86901307	MN -41	11:32001
1183	NTIS, PC A11/MF A01; 1 - GPO	TI86901409	MN -70B	11:31587
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1724	NTIS, PC A99/MF A01 - GPO	TI86002655	MN -80	11:31913
3064-Vol.1	NTIS, PC A05/MF A01 - GPO	TI86008415	MN -80	11:31885
3262-Vol.1	NTIS, PC A08/MF A01 - GPO	TI86010417	MN -78	11:31944
3957	NTIS, PC A06/MF A01	TI86009169	MN -80	11:31945
3959	NTIS, PC A06/MF A01 - GPO	TI86009172	MN -80	11:31860
3970	NTIS PC E04/MF A01; 1	TI86010794	MN -78	11:31946
4000-Vol.1	NTIS, PC A05/MF A01 - GPO	TI86009631	MN -41	11:32848
4027	NTIS, PC A06/MF A01 - GPO	TI86010795	MN -78	11:31947
4113	NTIS, PC A06/MF A01 - GPO	TI86901264	MN -11	11:32692
4124-Vol.2	NTIS, PC A04/MF A01 - GPO	TI86009592	MN -78	11:31948
4142	NTIS, PC A15/MF A01 - GPO	TI86010436	MN -78	11:31949
4319	NTIS, PC A19/MF A01 - GPO	TI86009630	MN -41	11:31605
4349	NTIS, PC A06/MF A01 - GPO	TI86008413	MN -80	11:31868
4353	NTIS, PC A04/MF A01 - GPO	TI86901160	MN -80	11:31950
4413	NTIS, PC A05/MF A01 - GPO	TI86009102	MN -78	11:31951
4467	NTIS, PC A03/MF A01 - GPO	TI86010636	MN -78	11:31952
4483	NTIS, PC A11/MF A01 - GPO	TI86010328	MN -78	11:31953
4488	NTIS, PC A03/MF A01 - GPO	TI86010581	MN -78	11:31954
4490-Vol.1	NTIS, PC A05/MF A01 - GPO	TI86010620	MN -78	11:31955
4543	NTIS, PC A03/MF A01 - GPO	TI86010638	MN -78	11:32248
4561	NTIS, PC A14/MF A01 - GPO	TI86010227	MN -41	11:31606
4583-Vol.1	NTIS, PC A05/MF A01 - GPO	TI86010604	MN -78	11:31804
NVO-				
196-41	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE86010448	MN -70	11:31517
ORNL-				
5970	NTIS, PC A20/MF A01; 1 (GPO Dep.)	E 1.99: DE86010061	STD -41	11:32761
6026/ V6/ A1	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86010087	MN -11	11:32764
6189	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010080	MN -32	11:32969
6213	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010070	MN -94a	11:31963
6216	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010069	MN -32	11:33263
6251	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99: DE86010063	STD -11	11:31413
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86/ 1	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99: DE86010060	STD -20c	11:33407
ORNL/M-				
132	NTIS, PC A05/MF A01; 1 (GPO Dep.)	E 1.99: DE86009590	MN -41	11:32849
140	Inst. for Radiation Hygiene, Ingolstaedter Landstrasse 1, D-8042, Neuherberg, Muenchen, Germany	TI86009014	ND -80	11:31874
141	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010268	MN -25	11:32153
143	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86009956	MN -11	11:32714
148	NTIS, PC A06/MF A01; 1 (GPO Dep.)	E 1.99: DE86010058	MN -61	11:31659
152	NTIS, PC A12/MF A01; 1 (GPO Dep.)	E 1.99: DE86010006	MN -11	11:32756
153	NTIS, PC A10/MF A01; 1 (GPO Dep.)	E 1.99: DE86010005	MN -11	11:32767
156	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86009975	MN -20	11:33408
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404	*See* NUREG/CR-1724	TI86002655	MN -80	11:31913
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84-9009/ 1	NTIS, PC A04/MF A01; 1 (GPO Dep.)	E 1.99: DE86008939	MN -95d	11:32257
85-69611/ 1	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99: DE86010418	MN -25	11:32236
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9667	NTIS, PC A03/MF A01 (GPO Dep.)	E 1.99: DE86010086	MN -69	11:32787
9787	NTIS, PC A08/MF A01 (GPO Dep.)	E 1.99: DE86010067	STD -90i	11:32781
9806	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010000	MN -90i	11:31321
9826	*See* NUREG/CR-4413	TI86009102	MN -78	11:31951
9904	NTIS, PC A04/MF A01 (GPO Dep.)	E 1.99: DE86009996	MN -13	11:33458
9919	NTIS, PC A05/MF A01 (GPO Dep.)	E 1.99: DE86010081	MN -32	11:33475
9931	NTIS, PC A02/MF A01; 1 (GPO Dep.)	E 1.99: DE86010072	MN -32	11:33284
9933	*See* NUREG/CR-4349	TI86008413	MN -80	11:31868
9953	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010085	MN -11	11:32757
9962	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010082	MN -32	11:33476
9966	NTIS, PC A03/MF A01; 1 (GPO Dep.)	E 1.99: DE86010076	MN -32	11:33477
9968-Vol.1	*See* NUREG/CR-3064-Vol.1	TI86008415	MN -80	11:31885
10003	NTIS, PC A05/MF A01 (GPO Dep.)	E 1.99: DE86010429	MN -13	11:32338
10016	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99: DE86010071	MN -32	11:33285
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124	GPO*			11:31652

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PB-				
85-917015/ XAB	NTIS, PC A03/MF A01			11:31986
86-135795/ XAB	NTIS, PC A14/MF A01			11:32133
86-135803/ XAB	NTIS, PC A15/MF A01			11:32134
86-135829/ XAB	NTIS, PC A99/MF A01			11:32135
86-135837/ XAB	NTIS, PC A17/MF A01			11:32136
86-135845/ XAB	NTIS, PC A99/MF A01			11:32137
86-135852/ XAB	NTIS, PC A09/MF A01			11:32138
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86-163789/ XAB	NTIS, PC A03/MF A01				11:32077
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86-900901	Transport. Energy Res., 16(15 Jan 1986) (GPO Dep.)	E 1.99:	DE86004269		11:32119
86-914400	Coal Combust. Utiliz., 86: No. No. 1, 5(15 Jan 1986) (GPO Dep.)	E 1.99:			11:31369
86-928600/ XAB	NTIS				11:31405
PCMRP-					
85-P5	*See* AEEW-R-1899		DE86702039	MN -71	11:32412
PNL-					
4710-Vol.1	*See* NUREG/CR-3262-Vol.1		TI86010417	MN -78	11:31944
5219-Vol.1	*See* NUREG/CR-4000-Vol.1		TI86009631	MN -41	11:32848
5275	NTIS, PC A23/MF A01; 1 (GPO Dep.)	E 1.99:	DE86006925	MN -11	11:31875
5727	*See* NUREG/CR-4483		TI86010328	MN -78	11:31953
5769	*See* NUREG/CR-3959		TI86009172	MN -80	11:31860
5822-Vol.1	*See* NUREG/CR-4583-Vol.1		TI86010604	MN -78	11:31804
PNL-SA-					
13789	NTIS, PC A02/MF A01 (GPO Dep.)	E 1.99:	DE86010218	MN -41	11:32850
PRI-					
98	*See* SAIC-86/1606	E 1.99:	DE86010665	STD -20g	11:33409
PSI-TR-					
259/ 542	NTIS, PC A08/MF A01; 1 (GPO Dep.)	E 1.99:	DE86003620	STD -90i	11:32730
PTB-SE-					
7	NTIS (US Sales Only), PC A05/MF A01		DE86751731	MN -70	11:31518
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019/ 82	*See* AD-A-164272/7/XAB				11:32545
R-					
85-956821-10	*See* PB-86-157153/XAB				11:32517
RAL-					
85-074	NTIS (US Sales Only), PC A04/MF A01		DE86701939	MN -34A	11:33223
85-088	NTIS (US Sales Only), PC A02/MF A01		DE86701923	MN -34D	11:33074
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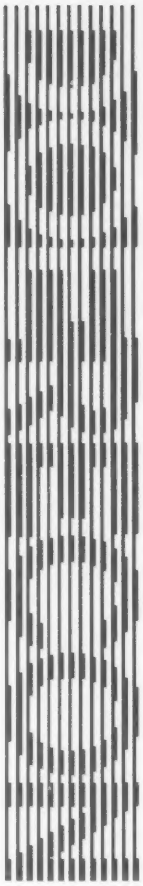

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